IDA REPORT R-345

REPORT OF THE TASK FORCE FOR IMPROVED COORDINATION OF THE DoD SCIENCE AND TECHNOLOGY PROGRAM

Volume I: Summary Report and Recommendations

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In November 1987 the Deputy Under Secretary of Defense, Research and Advance Technology, instructed the Institute for Defense Analyses (IDA) to assemble a Task Force, drawn largely from the community that carries out the Department of Defense's Science and Technology (S&T) program. This Task Force was chartered to "develop a strategy and an implementation plan for improving the coordination of resources and responsibilities among the DoD laboratories with an emphasis on strategic planning." The Task Force was formed and held an intensive series of meetings from January to July 1988, culminating in this report. Over 50 people were involved in the Task Force and its working groups, representing a cross section of senior personnel from all the DoD components responsible for science and technology, as well as representatives from the private sector.

Volume I of the report details the findings of the Task Force and its recommendations to the Director of Defense Research and Engineering. These recommendations are presented in terms of a strategy and a plan for improving the overall coordination, responsiveness, and efficiency of the Science and Technology program. Volume II of the report contains the reports of the Task Force's three working groups.

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Contract MDA 903 84 C 0031
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PREFACE

This document was prepared by a Task Force assembled by the Institute for Defense Analyses for the Deputy Under Secretary of Defense for Research and Advanced Technology under Contract No. MDA 903 84 C 0031, Task T-D6-563, *Task Force on Increased Coordination of Service Laboratory Activities*. The document, edited by IDA personnel, records the deliberations of the Task Force and presents its findings and recommendations, Volume I contains the summary and recommendations, and Volume II consists of the reports of the working groups. The recommendations presented here represent the consensus view of the group, which was selected to represent a cross section of the community that must implement the recommendations. It was understood throughout the evolution of this report that dissenting views would be accepted and included in the report, but none have been presented.

This document was reviewed by R.Adm. Leland S. Kollmorgen, USN (Ret.), Gen. Robert T. Marsh, USAF (Ret.), and Lt. Gen. Robert L. Moore, USA (Ret.) as a group, and also by Mr. Seymour J. Deitchman, IDA consultant. The review group included the following comment in its review:

> We believe the recommendations and accompanying action plans are stated in clear and understandable terms for ease of implementation. We believe that the underlying rationale and reasons for the conclusions and recommendations are clearly stated and adequately supported with one possible exception. The report concludes that the DoD S&T program deserves increased funding support in view of the nation's dwindling technological lead and our increased dependence upon such leadership to support our national security policy. This issue begs the question of how much funding is enough in light of other priorities--a question which does not lend itself to straightforward analysis and on which well informed people differ. It is understandable that a study group comprised of key managers of the S&T program would be biased in favor of increased support of their programs. The report reflects their unanimous belief that increased funding support is needed.

ACKNOWLEDGMENTS

Over 50 people having various associations with the DoD Science and Technology Program contributed to this report by serving on the Core Group and the three working groups that made up the Task Force. The work involved for each individual was significant--involving attendance at monthly two-day meetings over five months for the working groups and over seven months for the Core Group. In addition, work was required to prepare for the meetings and review the results as the reports were developed. In total, the Task Force members donated many thousands of man-hours to reaching the findings and recommendations contained in this report.

CONTENTS

Appendices

GLOSSARY

A. GENERAL TERMINOLOGY

Many of the terms used to describe "coordination" and "planning" processes for science and technology programs are subject to multiple interpretations. The Task Force adopted the following definitions:

S&T	Science and Technology. The Science and Technology Program consists of the programs in budget categories 6.1 (Research), 6.2 (Exploratory Development), and 6.3A (Advanced Technology Development). This report avoids the use of the term Technology Base, which is often used to refer only to the 6.1 and 6.2 budget categories, but sometimes includes 6.3A.
S&T Strategic Planning	A *process* of developing for the S&T program a strategy and an implementation plan for achieving an agreed-upon set of long range objectives.
S&T Investment Strategy	An S&T Investment Strategy establishes technology goals to meet stated objectives and shows the resources that are being applied to reach those objectives. It is the documentation resulting from the strategic planning process.
S&T Program Coordination	The process of compiling milestone and resource information on program content and formulation by S&T technology areas across all DoD Services and Agencies (such compilations are sometimes called "Technology Roadmaps").
Technical Coordination	The exchange of technical information, often at the working ("bench") level.
Roadmaps	See "S&T Program Coordination."

B. ACRONYMS

ASBREM	Armed Services Biomedical Research Evaluation and Management Committee
ATTD	Advanced Technology Transition Demonstration
BTI	Balanced Technology Initiative
C^3I	Command, Control, Communications, and Intelligence
CBW	Chemical Biological Warfare
CDI	Conventional Defense Initiative
CINC	Commander in Chief
CW/CBD	Chemical Warfare/Chemical Biological Defense
DAB	Defense Acquisition Board
DARPA	Defense Advanced Research Projects Agency
DIA	Defense Intelligence Agency
DDR&E	Director, Defense Research and Engineering
DNA	Defense Nuclear Agency
DSB	Defense Science Board
DUSD/R&AT	Deputy Under Secretary of Defense, Research and Advanced Technology
EMP/EMI	Electromagnetic Pulse/Electromagnetic Interference
EW	Electronic Warfare
FFRDC	Federally Funded Research and Development Center
FSED	Full Scale Engineering Development
FYDP	Five-Year Defense Plan
IR&D	Independent Research and Development
JDL	Joint Directors of Laboratories
JLC	Joint Logistics Commanders
JSCERDCG	Joint Services Civil Engineering Research and Development Coordinating Group
JSRG-CW/CBD-RDA	Joint Services Review Group - Chemical Warfare and Chemical-Biological Defense - Research, Development and Acquisition
MCP	Military Construction Programs

NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
OSD	Office of the Secretary of Defense
OTA	Office of Technology Assessment
POM	Program Objectives Memorandum
PPBS	Planning, Programming, and Budgeting System
R&AT	Research and Advanced Technology
R&D	Research and Development
RDA	Research, Development and Acquisition
RDT&E	Reserch, Development, Test, and Engineering
SDI	Strategic Defense Initiative
SECDEF	Secretary of Defense
SPO	System Program Office
TCG	Technology Coordinating Group
TCP	Technology Coordinating Panel
TD	Technical Director
TOA	Total Obligational Authority
USD(A)	Under Secretary of Defense (Acquisition)

EXECUTIVE SUMMARY

A. OVERVIEW

1. Purpose of the Task Force

This report presents the findings and recommendations of a Task Force, drawn largely from the community that carries out DoD's Science and Technology (S&T) program, that was chartered to "develop a strategy and an implementation plan for improving the coordination of resources and responsibilities among the DoD laboratories with emphasis on strategic planning." A fundamental concern is the erosion of the formerly dominant position of technological superiority in war-fighting capabilities enjoyed by the United States. In addressing this concern the Task Force finds there is an urgent need to improve the process through which investment decisions in science and technology are made, and to gain greater high-level management support for the investments. The recommendations developed by the Task Force address these needs.

2. Definition of "Strategic Planning" and "Coordination"

The Task Force sees the execution of the S&T Program under a strategic planning process as consisting of five elements: (1) S&T guidance which sets forth both near- and far-term military capability objectives; (2) an S&T Investment Strategy that establishes technology goals to meet these objectives and show the resources that are being applied to reach these objectives; (3) technology programming that lays out time-specific S&T technology programs that are needed to meet these technology goals; (4) allocation of resources to implement these technology programs; and (5) the provision of a feedback mechanism.

The Strategic Planning function per se is to establish and keep current the guidance and the investment strategy and get feedback from the programming and resource allocation processes to identify any disconnects for remedial action. The Program Coordination function is to provide this feedback by coordinating the technology programs into

roadmaps which show the program activities and resources that are directed at the established technology goals. Such roadmaps need to be time-based so that the elapsed time to meet both near- and far-term operational objectives is visible.

3. Changes Needed to Current System

Much of the above process is in place. However, there are two areas that need strengthening and these are addressed by Task Force recommendations:

- Need for a DoD-wide S&T Guidance and Investment Strategy
- Need for comprehensive DoD-wide Program Coordination.

The process that is envisaged is shown in Figure ES-1. The cross-hatched blocks in this figure are already largely in place in the Service/Agency Long Range S&T Plans. The open blocks are the main focus of the recommendations. While parts of these open blocks exist, the Task Force recommendations address strengthening both the strategic planning and the program coordination functions on a DoD-wide basis.

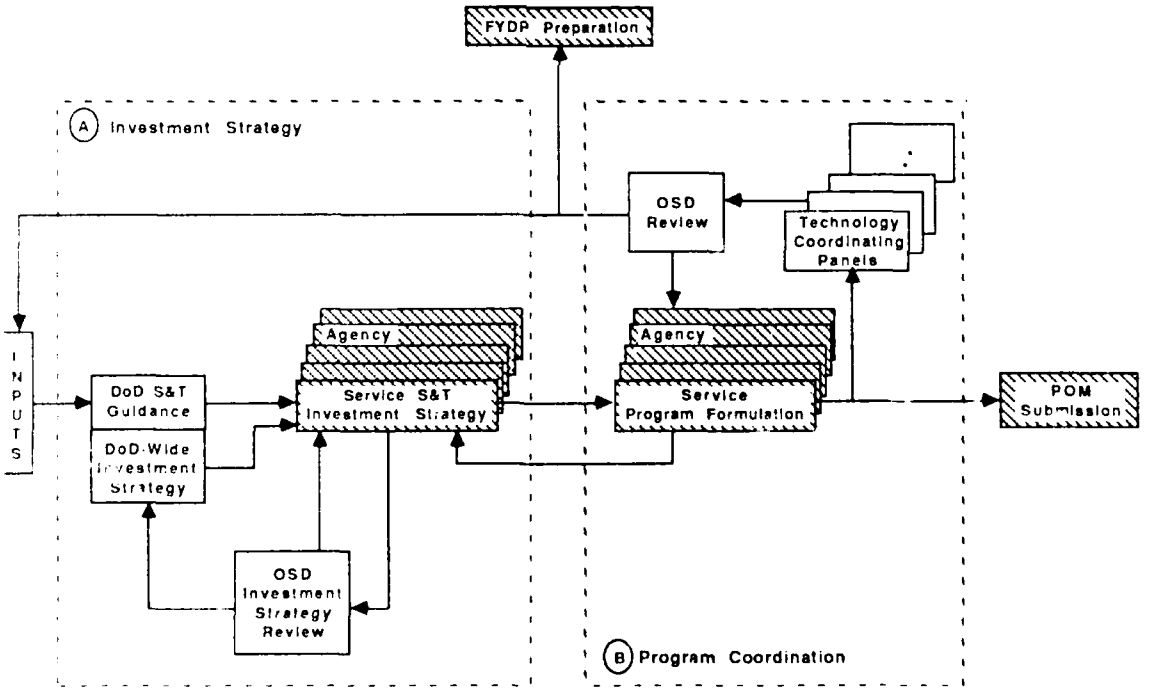

Figure ES-1. Overview of Proposed Planning and Coordination Processes

4. Perceived Benefits

With such an S&T strategic planning process in place it would be possible for management at all levels to review the S&T Program in order to optimize the investment in two ways--(1) over time and (2) by priority needs. Senior management should concentrate on establishing guidance and the investment strategy. The field agencies should develop programs to implement the strategy and then execute those programs in a coordinated, time-phased manner. These actions would also make advocacy for the S&T Program easier at the higher management levels.

a. Optimizing Over Time

One concern in investing in new technology is to balance the near-term and far-term investments properly. It is conventional wisdom that too much emphasis on near-term objectives is dangerous in a rapidly changing technological environment. It is also true that over-emphasis on long-term goals is not a good strategy either, since it drains resources from near-term objectives. The Strategic Defense Initiative (SDI) project and the attempt to offset it by establishing a Balanced Technology Initiative (BTI) program is an illustration of this point. The proper balance is a matter for executive decision, but this should be based on comprehensive information and a proper deliberative process. The process described here would present a comprehensive view on a time base to support such decision making.

b. Priority Needs

Another key element in S&T investment decisions is the distribution of resources at any given time to ensure that goals and objectives are being addressed with the right priorities. The process recommended here would allow the tracking of military capability priorities to technology programs and hence aid proper decision making in setting technology program priorities.

c. Advocacy

The uncertain nature of technology development programs and the typically long wait for a visible payoff (i.e., application to fielded systems) have always made it difficult to gain high level support for the S&T program investment. The proposed comprehensive strategic planning process will make it easier for top-level managers to see the ultimate value of such investments and for field managers to maintain resources to implement their programs.

B. FINDINGS AND RECOMMENDATIONS

1. Develop a DoD-Wide Investment Strategy

a. Findings

- There are existing long-range S&T plans within each of the Services and DoD Agencies, but these are not coordinated.
- A DoD-wide investment strategy is needed to tie these individual plans together.
- There should be feedback from the program execution process to the strategic planning process to identify any disconnects for remedial action.

b. Recommendations

The Secretary of Defense should reaffirm that a strong S&T program is essential to support the US policy of maintaining technological superiority in war-fighting capabilities. It is imperative that the S&T program be carefully focused on both near- and far-term needs so as to achieve the maximum returns on its investments. To this end, it is recommended that the Secretary of Defense establish a DoD-wide S&T strategic planning process under the direction of USD(A) as follows:

(1) DoD S&T Guidance

USD(A) will initiate and lead a participative and iterative process, executed by DDR&E, to produce DoD S&T Guidance. The participants in this process must include the appropriate S&T Program Secretariats of the Services, the Directors of the S&T activities from the Services and other DoD agencies, and representatives from the JCS, the CINCs, the Intelligence community, and others actively involved in the development and use of new technology for military purposes. The centerpiece of this process will be a document which should be used to formulate the S&T portion of the Defense Guidance and also be used by the Services and Agencies to guide the development of their Investment Strategies.

The DoD S&T Guidance should be developed from assessments of:

- the projected threat
- military/defense strategy
- operational needs and utility
- technological opportunities
- high level guidance (e.g., the President, Congress, Secretary of Defense)

- relevant activities in the non-DoD sector (e.g., industry, academia, etc.)
- prior year DoD S&T Guidance, investment strategies and programmatic assessments.

(See pp. III-8 to III-12 for details on the implementation of this recommendation.)

(2) Service/Agency Investment Strategies

USD(A) should direct the DoD Services and Agencies conducting S&T programs to develop and submit for review S&T Investment Strategies which are guided by and consistent with the DoD S&T Guidance.

These strategies should address or contain discussions of the following areas, showing the current and planned resources being applied to meet the objectives set forth in the DoD S&T Guidance:

- existing and projected war-fighting environment
- operational capabilities required
- broad system concepts expected
- key technology goals.

(See pp. III-12 to III-13 for details on the implementation of this recommendation.)

(3) Investment Strategy Reviews

The participants in the formulation of the DoD S&T Guidance should review the Service/Agency investment strategies and combine them into a DoD S&T Investment Strategy for approval by USD(A).

The review process should ensure that the submitted investment strategies:

- are responsive to the DoD S&T Guidance;
- are coordinated across other Services and Agencies, resolving conflicts and assigning leadership responsibilities;
- identify missing elements in the technology goals that are developed to meet stated objectives, and
- set priorities and resource allocations with respect to technology goals, the industrial technology base, and support to academia.

The result of this process will be a document containing the DoD S&T Guidance, the Service/Agency Investment Strategies and a summary chapter of the consolidated DoD investment strategy. This document, signed by the USD(A), will be referred to as the DoD

S&T Investment Strategy. (See p. III-13 for details on the implementation of this recommendation.)

2. Develop DoD-Wide S&T Program Coordination

a. Findings

- There is an abundance of technical interchange at the working levels, but there is a lack of S&T programmatic coordination at higher levels.
- Significant portions of the S&T program are outside the current S&T review process (e.g., those of DARPA, DNA, and SDI).
- A common set of technology areas or clusters is needed to facilitate coordination on a DoD-wide basis.

b. Recommendations

It is recognized that some elements of the S&T program do have effective tri-Service and inter-Agency program coordination today--for example, through OSD technical reviews and through the Joint Directors of Laboratories. However, to effect DoD-wide strategic planning, improved coordination is needed for all elements of the program. The following actions are needed to create a comprehensive programmatic coordination process:

(1) DoD-Wide Coordination Mechanism

USD(A) should establish a DoD-wide S&T Coordination Group charged with setting up and overseeing Technology Coordinating Panels (TCPs) for each technology area in the S&T Program. In the process of creating these panels the S&T Coordination Group should utilize as far as possible existing organizational structures, such as the Joint Directors of Laboratories and existing formal tri-Service agreements such as ASBREM.

These Technology Coordinating Panels will be chartered to:

- identify technology development shortfalls relative to system needs and technological surprise;
- identify unwarranted duplication, sub-critical mass resourcing, and general inefficiencies;
- provide a forum to ensure S&T information flow between the OSD staff, the Services, DoD agencies (e.g., DARPA) and Initiatives (CDI, BTI, SDI, etc.) in order to achieve programmatic balance and integration;
- ensure that technical information exchange makes effective use of computerization and electronic communication techniques;

- ensure consideration of industry, academic, and foreign technological efforts; and
- establish accountability for performance based on resource investment.

This mechanism or process is not intended to be used for resource allocation. (See pp. III-14 to III-19 for details on the implementation of this recommendation.)

(2) Standard Technology Areas

USD(A) should direct the S&T Coordination Group to adopt for its TCPs the set of 17 Technology Areas recommended below in the Action Plan (pages III-20 to III-22). This set of areas should be updated as necessary to be consistent with DoD objectives as defined in the DoD-wide S&T Guidance.

These standard technology areas will provide the basis for:

- facilitating review and communication throughout DoD;
- defining the technology basis for the investment strategy;
- defining the transition technologies for application in notional systems;
- structuring the coordinating mechanism; and
- assessing high-interest technology and DoD cooperative programs.

The Task Force notes that several of the technology areas already have effective coordination panels which could continue to operate as TCPs (see p. III-20). (See pp. III-19 to III-22 for details on the implementation of this recommendation.)

(3) Streamlining of Coordinating Groups

USD(A) should charter the S&T Coordination Group, after establishing the TCPs, to review other existing coordinating groups by:

- establishing criteria for the existence of tri-Service and inter-agency coordinating panels, committees, and other groups;
- evaluating the need for such existing groups according to the criteria; and
- recommending the retention of only those groups that meet the criteria.

(See pp. III-22 to III-23 for details on the implementation of this recommendation.)

3. Improve Advocacy for the S&T Program

a. Findings

- The high pay-offs to investments in science and technology are not well enough understood by many decision makers.
- The distinction between R&D and S&T--the latter is a small subset of R&D--is not fully appreciated.
- Just as in the private sector, science and technology investment must be viewed as a "cost of doing business," not a luxury that can only be afforded in good times.
- DoD's commitment to this "cost of doing business" is essential if the United States is to continue relying on a military strategy of technological superiority.

b. Recommendations

(1) Treat S&T as a Corporate Investment

It is imperative that the long term downward trend in S&T program investment (as a percent of Total Obligational Authority, exclusive of SDI) be arrested and replaced by rational goals for future growth. To accomplish this OSD should establish an end-of-FYDP goal, as a percent of TOA, for the required funding level of the S&T Program. This goal should be based on a coordinated DoD S&T Investment Strategy. Annual growth to achieve this goal should be required, and the S&T program should be protected against disproportionate cuts during budget exercises. This can only be accomplished by the issuance of a directive signed by the Secretary of Defense. Pending issuance of this directive, the SecDef should ensure that the FY90 S&T budget (exclusive of SDI) experiences positive real growth.

(2) Improve High-Level Management Support for S&T

To maintain support for investment in the S&T Program, improved advocacy is needed. The recommended DoD-wide S&T Investment Strategy should be actively used for this purpose:

(a) Improve high level advocacy to deliver message

- USD(A) should personally provide highly visible advocacy for the S&T program.
- Support of the S&T program should be articulated in all OSD, Service, and Agency posture statements.

- CINC and other user support must be cultivated by Service S&T program sponsors.
- USD(A) should direct that an annual review of the S&T program be given to the Defense Acquisition Board (DAB) by the Chairman of the S&T Committee of the DAB.

(b) Improve Communication of Science and Technology Program Successes

- Publish an unclassified DoD annual science and technology program report.
- Publicize significant S&T results by press releases.
- Encourage lab visits by Congressmen, DSB members, senior OSD and Service decision makers, etc.

(c) Improve Image of S&T Program Management

- SecDef should be periodically advised on S&T management issues.
- R&AT, with Service support, should provide an annual update to the DAB of S&T management improvements and ongoing actions.
- Publicize significant S&T management achievements and include in the unclassified DoD annual S&T program report.

I. TASK FORCE OBJECTIVES AND ACTIVITIES

A. THE CHARTER

In November 1987, the Institute for Defense Analyses was asked by the Deputy Under Secretary of Defense, Research and Advanced Technology (DUSD/R&AT) to assemble a cross section of Science and Technology (S&T) managers into a Task Force that would address ways to improve the effectiveness of the Defense Department's investments in Science and Technology programs. The Task Force was formed and held an intensive series of meetings from January through July 1988, involving over 50 senior S&T managers. This report sets forth their findings and recommendations.

The charter for the Task Force was "to develop a strategy and implementation plan for improving the coordination of resources and responsibilities among the DoD laboratories with emphasis on strategic planning. The study will identify the laboratory community's overall objectives, outline the major steps needed to accomplish them and recommend the means of implementation." This Task Force charter was set forth in an implementing memorandum issued on November 5, 1987, by the then Deputy Under Secretary of Defense for Research and Advanced Technology, Ronald L. Kerber.[1] When Dr. Kerber resigned in early 1988, the Director of Defense Research and Engineering, Dr. Robert C. Duncan, assumed sponsorship for the Task Force (see Appendix B).

The Task Force was instructed to focus on recommending ways in which methods of coordination could be continuously improved, rather than on trying to solve specific, current problems in various technical areas. This required that the Task Force focus on strategic planning and other broad mechanisms for improving coordination throughout the S&T community, not on personnel or budgeting issues. These latter issues are important, but they have been the subject of numerous other studies. Most recently some of these

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[1] Deputy Under Secretary of Defense (Research and Advanced Technology) Ronald L. Kerber, "Improved Coordination of DoD Science and Technology Programs," Memorandum, 5 November 1987. See Appendix B.

other issues were addressed in the 1987 DSB Summer Study, *Management of the Technology Base*. The work of this Task Force is considered complementary to that DSB study. The primary focus of the Task Force has been coordination within DoD and among DoD activities, rather than with other agencies or institutions (e.g., NSF, the Department of Energy, or NASA). Finally, the Task Force was asked to address primarily issues related to development and demonstration of technology uses in the 6.2 and 6.3A programs.

This final report recommends a strategy for improving coordination within the DoD S&T program and is backed by a plan for implementing that strategy. Since this strategy and implementation plan have been developed by a cross section of managers in the science and technology community, they are likely to be accepted and implemented by them and other participants in the S&T Program.

B. THE TASK FORCE

1. Core Group Activities

The work of the Task Force was initiated by assembling a core group whose initial agenda was to define the important issues to be addressed and to set up subgroups to address those issues. The Core Group consisted of senior representatives from each of the Services and from OSD. There was also representation from DARPA, from NASA, and from industry (see Table I-1 for the complete list of Task Force members). Retired senior officers from each Service with experience in managing science and technology activities were also included. The group thus represented a cross section of people experienced in and knowledgeable about the problems of maintaining a viable Science and Technology program.

The Service and OSD representatives are those who will play a major role in assuring that the recommendations of the Task Force are carried out. Their representation was considered critical to the development of recommendations that are not only sensible but are acceptable to those who must actually implement them. In addition, throughout the seven months that meetings of the Task Force were held, a constant effort was maintained to inform senior S&T managers about progress and preliminary conclusions. As well as informal communication between the participants in the Task Force and their managers, formal presentations were given to DDR&E, DUSD(R&AT) and his staff, and to the flag rank Service managers of the S&T program and their civilian aides. Reactions from these briefings were carried back to the Task Force members for their consideration.

Table I-1. The Core Group

Mr. Brett Able, Special Assistant to the Deputy Under Secretary of Defense for Research and Advanced Technology

Mr. Bob O. Benn, Assistant Director, Research and Development Directorate, Military Programs, U.S. Army Corps of Engineers

Dr. Gary L. Denman, Deputy Director, Air Force Wright Aeronautical Laboratories, WPAFB

Col. Joseph Denniston, Executive to the Assistant Surgeon General for Research and Development, U.S. Army

Mr. Monroe Dickinson, Division Director of the Technical Staff, IBM Federal Systems Division

Dr. Hamed El-Bisi, Deputy Director, Army Research & Technology (Research and Lab. Mgmt.), Office of the Assistant Secretary of the Army for Research, Development, and Acquisition

Mr. Michael Flynn, Technical Advisor, Directorate for Science and Technology, SAF/AQT, U.S. Air Force

Mr. Bruce Fonoroff, Director, Technology Planning and Management, LABCOM, U.S. Army

Mr. Richard Hartke, Director of Technology Programs, Aerospace Industries Association

Dr. Michael Kaplan, Director, Basic Research, U.S. Army Research Institute for the Behavioral and Social Sciences

R. Admiral Leland S. Kollmorgen, USN (Ret.), Former Chief of Naval Research, Chief of Naval Development

General Robert T. Marsh, USAF (Ret.), Former Commander, Air Force Systems Command

Col. James McCormack, Deputy DCS Technology and Requirements Planning, Air Force Systems Command

Lt. General Robert Moore, USA (Ret.), Former Deputy Commanding General for Research, Development and Acquisition, AMC, U.S. Army

Mr. Lewis Peach, Deputy Chief of Advanced Technology and Space Station Planning Office, NASA/Ames Res. Ctr.

Dr. Keith Richey, Technical Director, Air Force Wright Aeronautical Laboratories, AFWAL/CT, WPAFB

Mr. Raymond Standahar, Former Staff Specialist for Propulsion, OUSD/R&AT, Office of the Secretary of Defense

Mr. Marshall John Tino, Associate Technical Director, Naval Surface Warfare Center

Dr. William M. Tolles, Associate Director of Research for Strategic Planning, Naval Research Laboratory

Mr. Ben Wilcox, Assistant Director, Materiels Sciences, DARPA

The Core Group recognized that there is a widespread belief at the higher management levels that the productivity of the DoD laboratories needs improvement. Productivity problems involve the issues of management structure, personnel policies, contracting-out procedures, and the Program Planning and Budgeting System, which have been the subject of other studies, most recently in the 1987 DSB Summer Study of the Technology Base. What is addressed here is the need for improved strategic planning and technical coordination as additional essential elements of a productivity improvement plan--areas considered complementary to those covered by the DSB Study.

To address these areas, the Core Group focused on two key questions: (1) How can the investment of resources in the S&T program be optimized, and (2) how can high level support for the S&T program be obtained and maintained?[2] At its first two meetings the Core Group examined and debated the current policies and procedures for program coordination and for executing S&T plans and programs. These deliberations illuminated the fact that considerable *technical* coordination occurs at the laboratory and agency level.

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[2] This second question represents an extension of the Charter for the group. This was verbally approved by the sponsor at a review of the Interim Report in March 1988.

In truth, it may be that too many technical coordinating meetings occur. With respect to planning and programming, each of the Services has initiated efforts to formulate strategic plans for their S&T efforts. However, these planning efforts are not coordinated with or formulated against specific DoD guidance and priorities, nor are they coordinated across Services and Agencies.

The deliberations of the Core Group led to the extension of its charter and focused the group's attention on three key findings:

(1) *Integrated Planning.* While the planning of S&T programs within the Services is extensive, there is an insufficient level of integrated long term (5-20 year) DoD-wide planning. There is also a need for a more definitive relationship between S&T program goals and long range military requirements.

(2) *Coordination of Programs and Resources.* There are numerous existing groups that coordinate S&T activities. In spite of this, the perception persists outside the S&T community that there is a lack of coordination. Perhaps with so many DoD laboratories, often with overlapping areas of technical interest, this appearance is inevitable. What is needed are mechanisms to not only carry the coordination across the Services, but also to make that coordination visible to the higher management levels in OSD and to the political leadership. An apparent result of the perception of a lack of coordination is the institution of special programs (e.g., BTI) which, because of their special interest and ad hoc nature, often cause problems in the efficient planning, coordination, and execution of the overall S&T program.

(3) *Advocacy.* The S&T program is vulnerable to cuts in the budget process for numerous reasons. What is needed are ways to more clearly portray to senior decision makers the importance of a successful S&T program to the future military posture of the country. Two key elements of improved advocacy are better planning and improved high level coordination, as discussed above.

The current process for developing and reviewing the S&T program deals primarily with program element details. It thus forces all managers to deal in that level of detail in attempting to understand the overall direction of the program. For example, both the Investment Strategy Reviews and the S&T Reviews are primarily discussions of program details. They provide little, if any, insight into the perceived applications, battlefield needs, or tactical or strategic purposes against which to assess S&T program elements. It seemed to the Core Group that a more logical approach would be to reorient the process so that senior managers focus on planning objectives--on guidance and strategy--while the Services and Service laboratories build programs to satisfy those objectives. Programs

could be coordinated across agencies; joint efforts could be organized to more effectively deal with high priority needs, and time lines could be established so that technology could be managed and integrated into systems that meet the perceived threat on a timely basis.

To this end, the Core Group formed working groups to find logical solutions to the three key findings, building upon existing organizations and strengthening the purpose and outcome of the investment strategies.

2. Working Group Activities

The three working groups addressed ways to (a) improve the long range planning process and carry it to top management levels, (b) evaluate existing and new coordination mechanisms, with a view toward improving the coordination of programs and resources, and (c) improve the external and internal understandings of the importance of an effective S&T program in ensuring future war-fighting capabilities. The charters for each of these groups and the set of issues to be addressed by each, as set forth by the Core Group, are given in Appendix B together with a list of Working Group members.

Five meetings of each of these working groups were held from February through June 1988 at roughly monthly intervals. Each group produced a report that documented its specific recommendations. These are included in Volume II of this report. Their recommendations have been integrated by the Core Group into this summary report.

C. RELATIONSHIPS TO PREVIOUS STUDIES OF DoD LABORATORIES

The Task Force identified at least 22 studies of the DoD Research Laboratories that have been conducted over the last 25 years. The primary observation to be made concerning these many studies is that very few of them contain recommendations which address S&T strategy. They are thus not of major significance or relevance to the work of this Task Force.

The concern of most previous studies, including the 1987 Defense Science Board *Summer Study on Technology Base Management*, the 1982 "Hermann" Report, and the 1981 "Heilmeier" Defense Science Board Study, has been with management structure, personnel, contracting, and other issues that are encountered in operating the DoD research laboratories. Most studies have concentrated on how the management and efficiency of the laboratories could be improved, as distinct from the overall technical program of activities

undertaken by the laboratory community. Where the technical program has been addressed it has usually been to recommend specific areas for emphasis.

The 1987 *DSB Summer Study on Technology Base Management* included a review of 16 prior studies and categorized their recommendations according to the following management areas:

- Science and Technology Strategy
- Personnel
- Management and Organization
- Funding
- Peer Review and Performance
- Facilities and Equipment
- University/Industry/Service Interaction
- Technology Transfer
- Contracting.

A matrix showing which of these 9 issues was addressed in each of the 16 studies was constructed and is reproduced below in Appendix C.

Science and Technology Strategy--the subject of concern to this Task Force--was addressed in six of these studies and their recommendations have resulted in a number of actions. For example:

- The 6.3A Technology Demonstration Program was created.
- The Heilmeier "Top 17" technologies list was used to guide investment.
- Logistics R&D was strengthened.
- Lead laboratories were established in several selected technologies.

The primary objective of these recommendations was to guide portions of the Science and Technology program in specific directions. The premise of this Task Force is that it is not sufficient to state the need for a strategy or to suggest that a particular strategy be adopted. Instead what is addressed here is how to establish a *permanent process* for the development and execution of S&T strategy on a continuing basis.

II. FINDINGS

The fundamental concern of the Task Force is the erosion of the US military's formerly dominant position of technological superiority in war-fighting capabilities. This issue is discussed in Section A of this chapter. To address this problem the group finds there is a need to improve the process by which investment in Science and Technology programs are made and to gain greater high-level management support for the investment. These needs are addressed in Section B, "Strategic Planning;" Section C, "Coordination of Program Activities;" and Section D, "Advocacy."

A. EROSION OF TECHNOLOGICAL LEADERSHIP

Although it is not generally recognized, there has been a long-term decrease in the investment DoD makes in developing new technology. As the Defense Department now enters an era of tighter budget constraints, this trend could be accelerated. On top of this concern is the lack of a coherent picture at higher management levels of how investments in S&T programs are managed. This has been evident at the yearly Investment Strategy reviews at OSD, in Service budget deliberations, and in Congressional actions. These factors add up to a bleak picture for the prospects of reversing the downward trend in S&T investments.

On the other hand, there is an increasing need for a strong DoD S&T program to support the fundamental strategy of maintaining technologically superior war-fighting capabilities, and DoD cannot rely entirely on the industrial sector or on academia to fulfill this need. This conflict between decreasing investment in new technology and the increasing need for it is the main focus of the Task Force findings. The factors involved are discussed in more detail in the rest of this section.

1. Inadequate Investment in New Technology

Long Term Erosion in S&T. While the total investment in military R&D (actually RDT&E) has been increasing, the Science and Technology portion has been steadily decreasing (see Figure II-1).

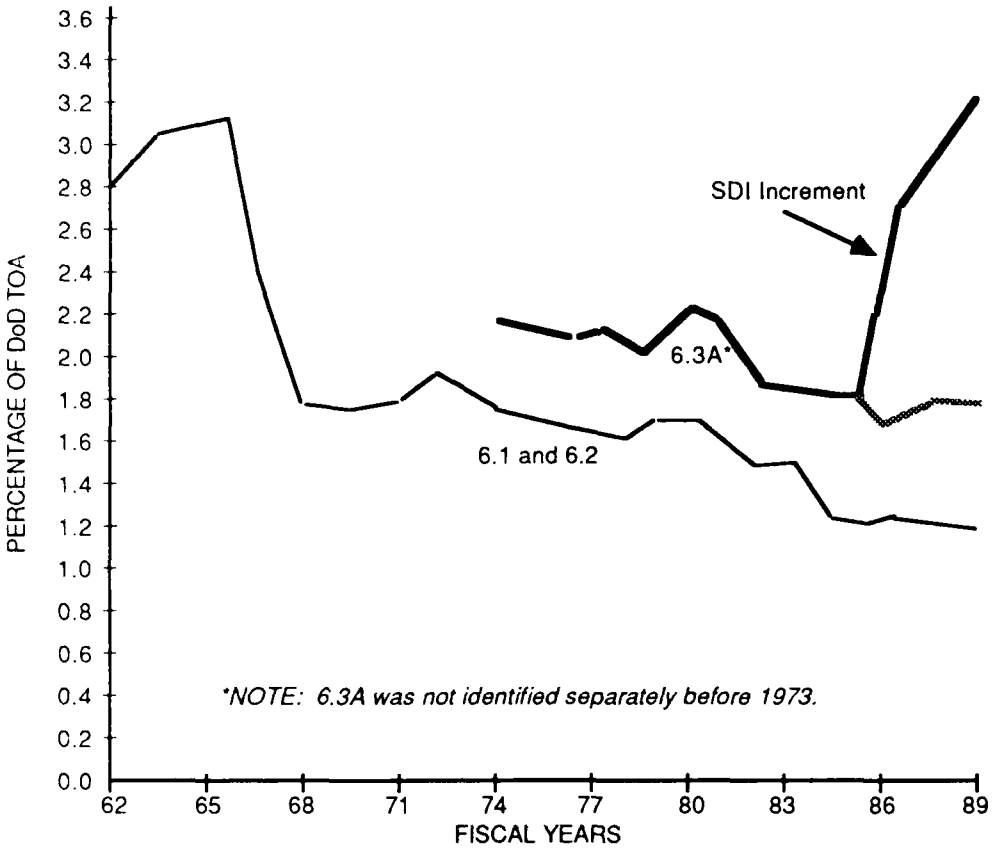

Figure II-1. DoD Science and Technology Funding (As a Percent of Total Obligational Authority)

Of particular concern is the steady decrease in the investment in the 6.1 and 6.2 areas which underlie all new technology applications. Even during the defense build-up of the 1980s the constant dollar investments in 6.1 and 6.2 programs decreased. This has been masked by the fluctuating investments in 6.3A programs, in particular by the very large investment in the Strategic Defense Initiative (SDI). The heavy investments in SDI, however, are related largely to the high cost of space experiments and the development of pre-prototype hardware, and do not constitute significant investments in the 6.1 and 6.2 areas, in technologies of general use to DoD.

Potential Impact of Tighter Budgets. In comparison to the overall DoD budget ($283 billion in FY 1988) or the investment portion, i.e., procurement and RDT&E ($118 billion) or even the RDT&E budget alone ($37 billion), the investment of $5.2 billion--or less than 2 percent of DoD's total obligational authority--in the science and technology programs is relatively small. Unfortunately, during budget-cutting exercises the S&T program is often cut in favor of investments with more immediate impact. Furthermore,

the high first-year outlay rate of S&T investments makes it a tempting target during budget preparation exercises.

Lack of Integrated S&T Investment Strategies. Each year the Military Services prepare formal S&T investment strategies. Each Service completes its own review, and then presents it to OSD for final review. Unfortunately, little guidance with respect to perceived military capabilities needs exists to help direct agency planning. Furthermore, the agencies are not required to review their programs collectively so as to find ways to build on each others' programs, ensure against unwarranted duplication of effort, assign leadership over critical technological efforts, and manage technology insertion against timeliness of need.

The Services have seen the need for strategic planning, and each Service is moving to structure its programs so as to satisfy strategic guidance and perceived military capabilities needs. Although such efforts are relatively new, the Task Force applauds these efforts and believes they provide a basis upon which to build a DoD strategic planning process. Senior management needs an integrated strategic planning process in order to better understand and advocate the S&T program. Laboratories and agencies need such a process to guide them in their program formulations and application of resources.

2. The Need for a Strong DoD S&T Program

US Military Strategy is Based on Technological Superiority. One of the cornerstones of US military strategy is to maintain and advance the qualitative superiority of its weapons so as to offset the numerical advantages and growing technological sophistication enjoyed by the Soviet Union. This fact was given prominence in the most recent edition of *Soviet Military Power: An Assessment of the Threat, 1988*:

> "As part of the United States' deterrent strategy, it relies heavily on technological rather than numerical superiority. Its strong technological position has always balanced sheer Soviet numerical advantages and thereby added to deterrence."[3]

The Technological Gap Between the United States and the Soviet Union is Narrowing. This same source also points out that:

> "[The] Soviets are clearly committed to dedicating the R&D resources necessary to improve their weaponry. Indeed, the technological advantages in military capabilities now enjoyed by the West have been threatened, if not eroded...If [the Soviets] seize the

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[3] U.S. Department of Defense, *Soviet Military Power: An Assessment of the Threat, 1988*, p. 140.

> initiative and continue to reduce the West's technological advantages, the United States and its allies will be forced to expend even greater resources, or accept greater risks to collective security...It is imperative, therefore, that the United States invest wisely to maintain its technological advantages."[4]

Many DoD S&T Needs Cannot be Met by the Commercial Sector. The role of the science and technology program is to ensure that all of DoD's future military capability needs will be met. DoD seeks to fulfill this role without the undue duplication of efforts being supported elsewhere, including other government laboratories, industry, or universities. There are a number of important reasons for DoD to make its own investments in science and technology: (a) the need to support high-risk, high pay-off projects, (b) the existence of unique military requirements, (c) the need to understand, push, and exploit emerging technologies, and (d) the need to demonstrate the military applications of specific technologies.

High Leverage Provided by Investments in S&T. The need to invest for the future by investing in technological development is a well-recognized fact, not only in the military arena but also in commercial markets. The need for technological innovation is never-ending in a competitive environment. US technological leadership must be nurtured and fed. The United States owes much of its current technological lead in military systems to investments in the S&T program that were made 15 to 20 years ago. Examples include stealth platforms, cruise missiles, turbine engines, lasers, microelectronics, and submarine and space advances. The challenge today is not only to continue making the same investments in our future, but to recognize that the need to nurture new technologies is even greater today than it has been in the past.

B. STRATEGIC PLANNING

1. Existing S&T Planning and Review Processes

There is a significant amount of long-range planning currently going on within each of the Services and Agencies. Appendices B, C, and D of the Report of Working Group A on "Strategic Planning" (see Volume II of this report) give summaries of current Service and Agency long-range planning methods. The lowest level at which this planning occurs usually includes two perspectives:

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[4] *Ibid.*, p. 140.

(1) A five-year business plan

(2) A 5-20 year strategic plan.

The purpose of these long-range plans has historically been to guide the investment of research and development (R&D) resources within each Service. Recently, Service R&D organizations, as well as the Service staffs, have been developing more comprehensive S&T investment strategies as integral parts of their business plans. These efforts are, at the moment, pursued independently within each of the Services and, to some degree, independently at the R&D center level.

Typically, the Deputy Under Secretary of Defense for Research and Advanced Technology (DUSD/R&AT) conducts an annual investment strategy review of each Service. The appropriate Service Director of Laboratories provides an overview of the Service S&T Program followed by laboratory briefings which cover a mission statement, people and funding trends, facilities (including Military Construction Programs), selected major technology thrusts, accomplishments, transition efforts, and new starts. Specific guidance is provided for DUSD/R&AT reviews, but not for the Service investment strategies.

2. Weaknesses in the Current Process

The current process has several shortcomings. First, in the absence of specific planning guidance, it is difficult to assess the individual Service investment strategies and their relation to overall DoD objectives. Second, the reviews concentrate on current phase programs, for which there is little flexibility at the time the review is conducted. Furthermore, since each Service is reviewed separately, the relationship of their programs to each other is also difficult to assess. Finally, other than the verbal comments received from R&AT during the actual review, no formal or written feedback is provided to the Services. Thus the investment strategy reviews serve primarily as an information gathering function.

There is strong interaction at the programmatic level among the Services and the defense agencies such as DARPA, and the technology base programs of these agencies are generally complementary to Service programs. If, however, these agencies have their own investment strategies, it is not apparent to the Services. Although programs are coordinated at the working level, any high-level reviews of the Agencies' programs seldom involve the Services. Considering the extent and impact of their programs, the investment strategies of other DoD agencies should be reviewed at the same level as the Service investment

strategies, and should be factored into an overall DoD strategy. In the absence of such inputs and reviews OSD cannot perform a complete assessment of the objectives, priorities, and merit of the total DoD science and technology program.

3. Need For DoD-Wide Strategic Planning

A coordinated DoD investment strategy is needed that will tie together the investment strategies as they currently exist in the Services and Agencies. Strategic planning must be seen as a necessary part of the S&T program's formulation and execution. It involves establishing and keeping current: (1) an S&T guidance document that sets forth near- and far-term capabilities objectives and (2) an investment strategy that establishes technology goals to meet these objectives. Strategic planning also involves getting feedback from the technology programming and resource allocation that is carried out to meet the technology goals. The feedback from these execution phases to the guidance and investment strategy is necessary to identify any disconnects that need remedial action either by modifying the strategy or changing priorities in the execution process. If the strategic planning process is to be effective, senior management must be actively involved.

C. COORDINATION OF PROGRAM ACTIVITIES

1. Need for DoD-Wide S&T Coordination Mechanism

As noted above, having established guidance and an investment strategy, the strategic planning function requires feedback from the programming and resource allocation processes in each Service and Agency so as to identify any problems requiring remedial action. This feedback requirement creates a need for the technology programming performed by each of the Services and Agencies to be coordinated across the whole of DoD's S&T activities to ensure that the "corporate" technology goals in the Investment Strategy are being addressed comprehensively and in a timely manner.

Such a comprehensive view of the S&T program by technology area, relatable to operational needs, would greatly assist DDR&E and DUSD(R&AT) in advocating support for the DoD S&T program to higher levels of DoD management, the Services, and Congress. In an era of tighter budgets, such advocacy needs strengthening to defend the S&T program investment in its competition with the much larger investment demands of systems already in development. Furthermore, the provision of a coordinated view of S&T

programs by technology area with time-based technology development roadmaps would provide a means of tracking accountability at all levels by coupling programs and results to strategic guidance.

The current system does not result in a DoD-wide strategic coordination of the S&T program. There is thus a need for a coordination mechanism with DoD-wide representation to coordinate technical projects and programs. If possible, this mechanism should be created by modifying or expanding an existing mechanism or group or by combining several mechanisms or groups in order to represent a comprehensive set of technology areas (clusters) in the S&T program.

2. Need for Standard Technology Areas

In order to effect S&T programmatic coordination across DoD, a need exists to define a set of common technology areas or clusters which are compatible with existing management practice. This is essential so as to relate appropriate programs in different Services and Agencies. Lists of the technology areas used within the existing infrastructure have been examined by the Task Force, and no entirely consistent set of technology areas among the Services, OSD, and present coordinating bodies exists at present. A standard set of technology areas is needed to:

- minimize bureaucratic problems
- facilitate review and communication throughout DoD
- define a common basis for investment strategy and long-range planning
- define the transition technologies for application in notional systems
- provide the basis for structuring the programmatic coordinating mechanism
- provide a better mechanism for DoD cooperative programs and assessments of high-interest technology.

3. Need for a Streamlining of Current Tri-Service and Inter-Agency Coordinating Groups

A large number of groups exist within and outside the DoD for the purpose of exchanging scientific and technical information. A partial list of over 200 tri-Service and inter-Agency coordination groups was assembled by the Task Force (see Volume II, Working Group B, Appendix E). Despite this large collection of information exchange and coordinating groups there is general agreement that programmatic coordination needs

improvement. Streamlining the information exchange process could be an effective way to improve productivity.

D. ADVOCACY

1. Need to View S&T Program Costs as a Corporate Investment

The narrowing of the technological gap between the United States and the Soviet Union has potentially far-reaching implications for the US military posture. Reversing this trend must be seen as one of the main priorities of the Department of Defense in the years ahead. DoD's science and technology community can continue to provide the advances required for technologically superior war-fighting capabilities only if it is provided sufficient support from the higher management levels in DoD and in Congress. The long-term value of investments in Science and Technology R&D must not be eroded by budget decisions in favor of more immediate short-term requirements. The relatively small amount of resources devoted to Science and Technology programs--less than 2 percent of the entire DoD budget--should be treated as a necessary cost of retaining superior war-fighting capabilities over the long term. S&T program costs must be viewed as an essential corporate investment.

2. Need to Gain Better High-Level Support

Part of the advocacy problem that the S&T program faces is directly attributable to its relatively small size which, from a financial viewpoint, tends to make it a second order consideration. To offset this tendency, the fact that the S&T program is the cornerstone of future US technological superiority in its war-fighting capabilities needs to be constantly communicated to the senior decision makers in DoD. They in turn must become explicit and pro-active advocates of S&T program investments.

In order to support the senior decision makers' advocacy of the S&T program, they must be kept better informed of its objectives, accomplishments, and contributions. No one can be expected to support a program on faith alone. An additional benefit of providing such improved communication will be an increased emphasis on management and productivity improvements. The increased visibility will make S&T program managers more accountable for meeting the program objectives that have been set.

E. SUMMARY OF FINDINGS

1. Erosion of Technological Leadership

- The technological gap between US and Soviet military forces has been narrowing.
- There has been a steady decrease in our investment in new technology, particularly 6.1 and 6.2 programs, over the last 20 years.
- The environment for increasing S&T investment is not favorable and needs to be changed.

2. Strategic Planning

- There exist long-range S&T plans within each of the Services and DoD Agencies, but these are not coordinated.
- A DoD-wide strategic plan, including an investment strategy is needed to tie these individual plans together.
- Annual investment strategy reviews should be carried out against this comprehensive strategic plan.
- There should be feedback from the program execution process to the strategic planning process to identify any disconnects that need remedial action.
- Senior management in OSD and the Services should concentrate on establishing the guidance and the investment strategy, and on ensuring that programs are in place to satisfy the strategy.

3. Programmatic Coordination

- There is an abundance of technical interchange at the working levels, but there is a lack of Science and Technology programmatic coordination at higher levels.
- Significant portions of the S&T program are outside the current S&T review process conducted by DUSD(R&AT) (e.g., those of SDI, DARPA, and DNA) and this situation needs to be remedied.
- A programmatic coordination mechanism, including a coherent review process, designed to focus information on the DoD-wide S&T programs, is needed to make sure that resources are being allocated effectively.
- A common set of technology areas or clusters is needed to facilitate coordination on a DoD-wide basis.

4. Advocacy

- The level of investment in S&T programs has been eroding and this trend should be reversed.
- There is a need for continuing advocacy for the S&T Program at the highest management levels.
- S&T Program successes should receive more intensive reviews on a regular basis.

III. RECOMMENDATIONS

The Task Force envisions the execution of the S&T Program under a strategic planning process as consisting of five elements: (1) S&T guidance which sets forth both near- and far-term military capability objectives; (2) an S&T Investment Strategy that establishes technology goals to meet these objectives and shows both the resources that are required and being applied to reach these objectives; (3) technology programming that lays out time-referenced S&T technology programs that are needed to meet these technology goals; and (4) allocation of resources to implement these technology programs; and (5) the provision of a feedback mechanism.

The Strategic Planning function per se is to establish and keep current the guidance and the investment strategy and to obtain feedback from the programming and resource allocation processes to identify any gaps or disconnects requiring remedial action. The Program Coordination function is to provide this feedback by coordinating the technology programs into roadmaps which show the program activities and resources that are directed at the established technology goals. Such roadmaps need to be time-based so that elapsed time to meet both near- and far-term operational objectives is visible.

Much of the above process is in place. However, there are two areas that need strengthening and these are addressed by Task Force recommendations:

- Need for a DoD-wide S&T Investment Strategy
- Need for comprehensive DoD-wide Program Coordination.

Recommendations in each of these areas and also on ways to strengthen advocacy for the S&T investment are presented below as (A) policy recommendations for actions OSD should take and (B) an action plan to implement these policies.

A. POLICY RECOMMENDATIONS

1. Develop a DoD-Wide S&T Investment Strategy

The Secretary of Defense should reaffirm that a strong S&T program is essential to support the US policy of maintaining technological superiority in war-fighting capabilities. It is imperative that the S&T program be carefully focused on both near- and far-term needs so as to achieve the maximum returns on its investments. To this end, it is recommended that the Secretary of Defense establish a DoD-wide S&T strategic planning process under the direction of USD(A), one that includes all organizations involved in the conduct of S&T. This process should lead to specific DoD S&T Guidance which would be used by the Services and Agencies to formulate their S&T Investment Strategies, which will in turn be reviewed by USD(A).

a. DoD S&T Guidance

USD(A) will initiate and lead a participative and iterative process, executed by DDR&E, to produce DoD S&T Guidance. The participants in this process must include the appropriate S&T Program Secretariats of the Services, the Directors of the S&T activities from the Services and other DoD agencies, and representatives from the JCS, the CINCs, the Intelligence community, and others actively involved in the development and use of new technology for military purposes. The centerpiece of this process will be a document which should be used to formulate the S&T portion of the Defense Guidance and also be used by the Services and Agencies to guide the development of their Investment Strategies.

The DoD S&T Guidance should be developed from assessments of:

- the projected threat
- military/defense strategy
- operational needs and utility
- technological opportunities
- high level guidance (e.g., the President, Congress, Secretary of Defense)
- relevant activities in the non-DoD sector (e.g., industry, academia, etc.)
- prior year DoD S&T Guidance, investment strategies and programmatic assessments.

(See pp. III-8 to III-12 for details on the implementation of this recommendation.)

b. Service/Agency Investment Strategies

USD(A) should direct the DoD Services and Agencies conducting S&T programs to develop and submit for review S&T Investment Strategies which are guided by and consistent with the DoD S&T Guidance.

These strategies should address or contain discussions of the following areas, showing the current and planned resources being applied to meet the objectives set forth in the DoD S&T Guidance.

- existing and projected war-fighting environment
- operational capabilities required
- broad system concepts expected
- key technology goals.

(See pp. III-12 to III-13 for details on the implementation of this recommendation.)

c. Investment Strategy Reviews

The participants in the formulation of the DoD S&T Guidance should review the Service/Agency investment strategies and combine them into a DoD S&T Investment Strategy for approval by USD(A).

The review process should ensure that the submitted investment strategies:

- are responsive to the DoD S&T Guidance;
- are coordinated across other Services and Agencies, resolving conflicts and assigning leadership responsibilities;
- identify missing elements in the technology goals that are developed to meet stated objectives; and
- set priorities and resource allocations with respect to technology goals, the industrial technology base, and support to academia.

The result of this process will be a document containing the DoD S&T Guidance, the Service/Agency Investment Strategies and a summary chapter of the consolidated DoD investment strategy. This document, signed by the USD(A), will be referred to as the DoD S&T Investment Strategy. (See p. III-13 for details on the implementation of this recommendation.)

2. Develop DoD-Wide S&T Program Coordination

An element that needs strengthening for an overall strategic planning process is the programmatic coordination of S&T programs across all DoD Services and agencies. It is

recognized that some elements of the S&T program do have effective tri-Service program coordination today, for example, through the Joint Directors of Laboratories (JDLs) and through OSD technical reviews. However, to effect DoD-wide strategic planning, improved coordination is needed for all elements of the program. The following actions are needed to create a comprehensive programmatic coordination process:

a. DoD-Wide Coordination Mechanism

USD(A) should establish a DoD-wide S&T Coordination Group charged with setting up and overseeing Technology Coordinating Panels (TCPs) for each technology area in the S&T Program. In the process of creating these panels the S&T Coordination Group should utilize existing organizational structures, for example, JDL committees and ASBREM, as much as possible, establish a single S&T Review process.

These Technology Coordinating Panels will be chartered to:

- identify technology development shortfalls relative to system needs and technological surprise
- identify unwarranted duplication, sub-critical mass resourcing, and general inefficiencies
- provide a forum to ensure S&T information flow between the OSD staff, the Services, DoD agencies (e.g., DARPA) and Initiatives (CDI, BTI, SDI, etc.) in order to achieve programmatic balance and integration
- ensure that technical information exchange makes effective use of computerization and electronic communication techniques
- ensure consideration of industry, academic, and foreign technological efforts
- establish accountability for performance based on resource investment.

This mechanism or process is not intended to be used for resource allocation. (See pp. III-14 to III-19 for details on the implementation of this recommendation.)

b. Standard Technology Areas

USD(A) should direct the S&T Coordination Group to adopt for its TCPs the set of 17 Technology Areas recommended below in the Action Plan (pp. III-20 to III-22). This set of areas should be updated as necessary to be consistent with DoD objectives as defined in the DoD-wide S&T Guidance.

The technology areas/clusters will provide the basis for:

- facilitating review and communication throughout DoD
- defining the technology basis for the investment strategy

- defining the transition technologies for application in notional systems
- structuring the coordinating mechanism
- assessing high-interest technology and DoD cooperative programs.

(See pp. III-19 to III-22 for details on the implementation of this recommendation.)

c. Streamlining of Coordinating Groups

USD(A) should charter the S&T Coordination Group, after establishing the TCPs, to review other existing coordinating groups by:

- establishing criteria for the existence of tri-Service and inter-agency coordinating panels, committees, and other groups;
- evaluating the need for such existing groups according to the criteria; and
- recommending the retention of only those groups that meet the criteria.

(See pp. III-22 to III-23 for details on the implementation of this recommendation.)

3. Improve Advocacy for the S&T Program

The high payoff to investments in science and technology are not well enough understood by many important decision makers. Just as in the private sector, science and technology investment must be considered a necessary cost of doing business, not a luxury that can only be afforded in good times. DoD's commitment to this cost of doing business is essential if the United States is to continue to rely on a military strategy of technological superiority.

a. Treat S&T as a Corporate Investment

It is imperative that the long term downward trend in S&T program investment (as a percent of Total Obligational Authority, exclusive of SDI) be arrested and replaced by rational goals for future growth. To accomplish this OSD should establish an end-of-FYDP goal, as a percent of TOA, for the required funding level of the S&T Program. This goal should be based on a coordinated DoD S&T Investment Strategy. Annual growth to achieve this goal should be required, and the S&T program should be protected against disproportionate cuts during budget exercises. This can only be accomplished by the issuance of a directive signed by the Secretary of Defense. Pending issuance of this directive, the SecDef should ensure that the FY90 S&T budget (exclusive of SDI) experiences positive real growth.

b. Improve High-Level Management Support for S&T

To maintain support for investment in the S&T Program, improved advocacy is needed. The recommended DoD-wide S&T Investment Strategy should be actively used for this purpose:

(1) Improve high level advocacy to deliver message

- USD(A) should personally provide highly visible advocacy for the S&T program.
- Support of the S&T program should be articulated in all OSD, Service, and Agency posture statements.
- CINC and other user support must be cultivated by Service S&T program sponsors.
- USD(A) should direct that an annual review of the S&T program be given to the Defense Acquisition Board (DAB) by the Chairman of the S&T Committee of the DAB.

(2) Improve Communication of Science and Technology Program Successes

- Publish an unclassified DoD annual science and technology program report.
- Publicize significant S&T results by press releases.
- Encourage lab visits by Congressmen, DSB members, senior OSD and Service decision makers, etc.

(3) Improve Image of S&T Program Management

- SecDef should be periodically advised on S&T management issues.
- R&AT, with Service support, should provide an annual update to the DAB of S&T management improvements and ongoing actions.
- Publicize significant S&T management achievements and include in the unclassified DoD annual S&T program report.

An overview of the recommended process, detailed below, is provided in Figure III-1. The dates reflect deadlines that must be met in order for the process to be synchronized with the PPBS cycle (see discussion on pp. III-14 to III-23).

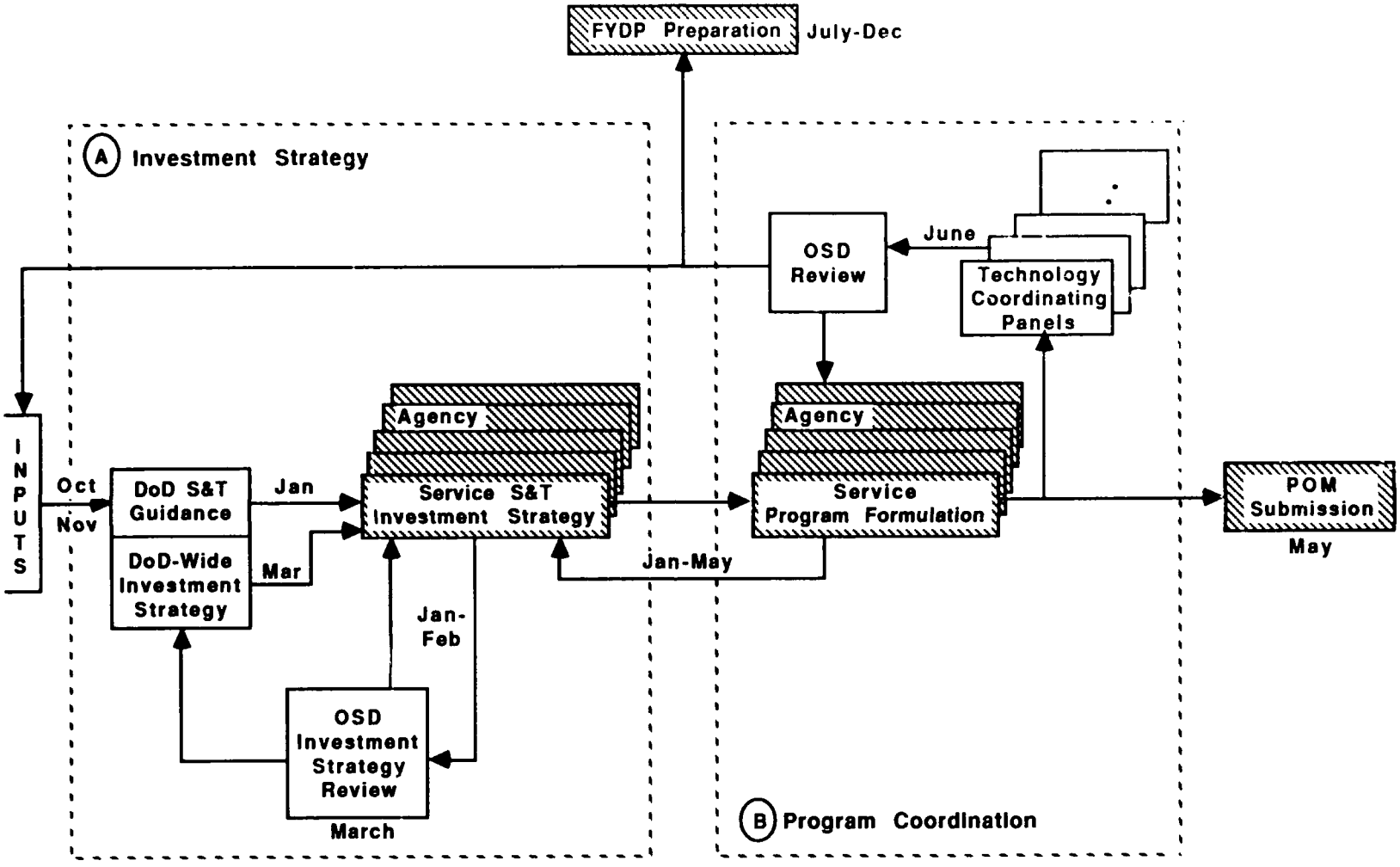

Figure III-1. Overview of Proposed Planning and Coordination Processes

B. ACTION PLANS FOR IMPROVING COORDINATION IN THE S&T PROGRAMS

1. DoD-Wide S&T Investment Strategy

a. Overview of Recommended Implementation Process

To develop a coordinated DoD S&T Investment Strategy, a process involving three major elements is needed:

I. Development and promulgation of a DoD S&T Guidance document which is based upon: (1) National defense long-range objectives; (2) the war fighting operational environment expected in the 21st century; (3) an intelligence assessment of the threat evolution over the next 20 years; and (4) a geopolitical assessment of our own and our adversaries' likely roles in the 21st century. The DoD S&T Guidance should highlight significant changes to be expected, critical issues and requirements, and priorities, alternatives, and fall-back options. The strategic guidance should be developed under directive from USD(A) and involve the appropriate R&D Secretariats of the Services together with heads of the research laboratories' activities from the Services and other DoD agencies, and representatives from the JCS and the Intelligence communities.

II. Development and coordination of the separate Service/Agency S&T Investment Strategies.

III. OSD review of the Service/Agency S&T Investment Strategies to assure the investment strategies are consistent with the DoD S&T Guidance. When the Service/Agency S&T Investment Strategies have been approved, DDR&E produces a DoD S&T Investment Strategy which includes the DoD S&T Guidance, the individual Service/Agency Investment Strategies, and a summary which consolidates the individual investment strategies.

An overview of the proposed process appears in Figure III-2.

b. The DoD S&T Guidance

S&T guidance must be responsive to existing and projected threats, result in improved war fighting capabilities, and provide a long-term (5-20 year) view. Part of the guidance will be specific development goals which will assure the availability of mature technologies to meet future threats and support national objectives. Specific 5-20 year

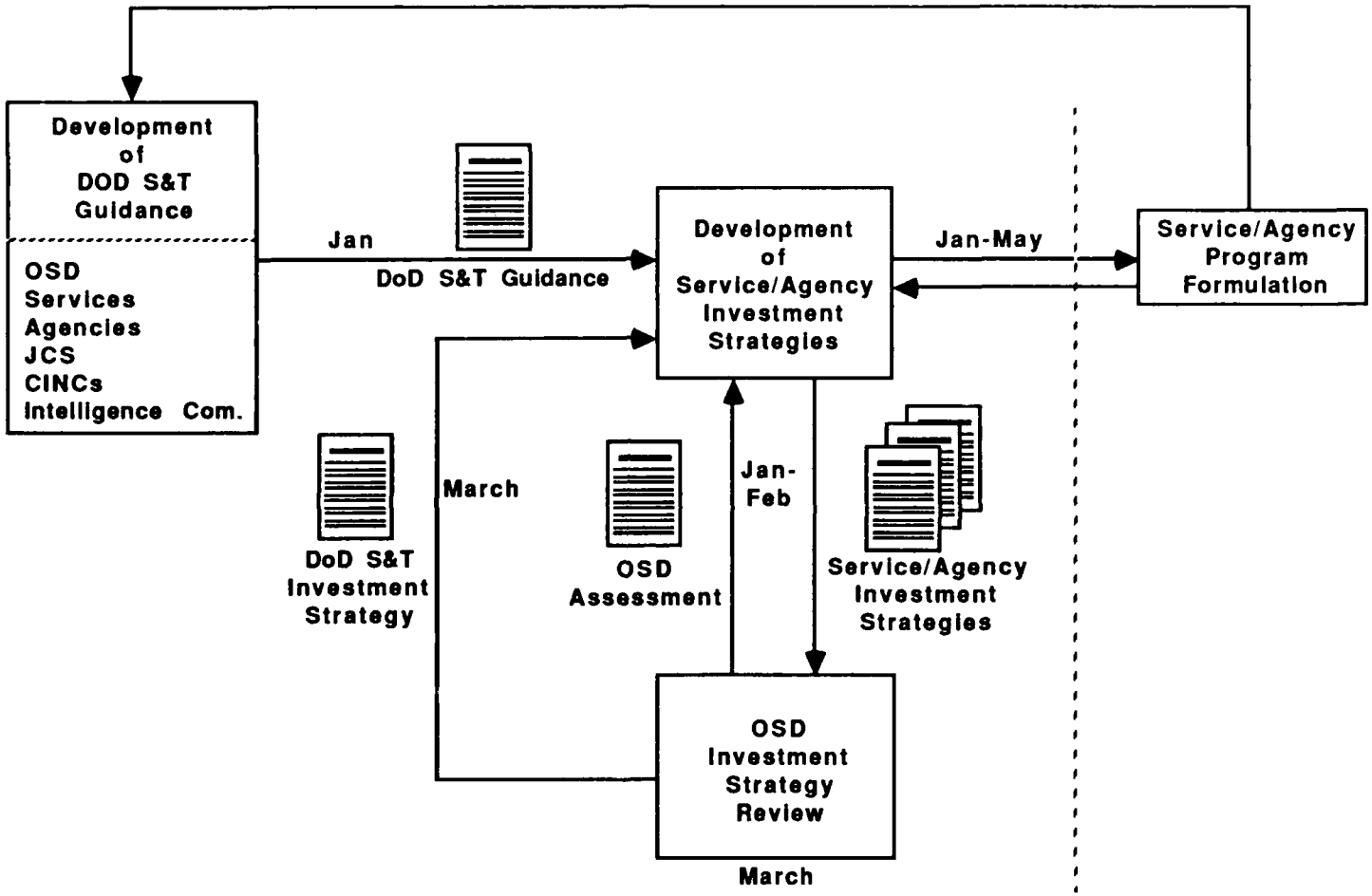

Figure III-2. Process to Develop a Coordinated DoD S&T Investment Strategy

development goals will focus numerous S&T efforts and spawn new ones to fill gaps in the S&T program. Some example objectives are:

a. A real-time global capability to detect, track, and identify low observables.

b. Survivable, adaptive communication capability.

c. Rapid, worldwide deployment of forces within hours.

Such broad requirements should provide sufficient direction for the Services and other DoD agencies to develop the technology goals for new or improved sensors, weapons, platforms, etc., along with supporting technologies in electronics, materials, propulsion, structures, etc. Clearly, both near- and long-term goals for S&T must be driven by the need to respond to existing and projected threats. The long-term goals should challenge the S&T community to be innovative in providing new war-fighting capabilities that can meet the national security objectives expressed in the DoD S&T Guidance.

In establishing this guidance, OSD must use inputs from the technologists (S&T Programs), the operators (JCS), the political-military policy community, and the intelligence community. Only through dialogue between these communities can there be a realistic identification of existing and projected threats and a clear definition of promising technologies and military capabilities requirements.

The DoD S&T Guidance should be developed from (1) the projected threat (the intelligence community and military planners); (2) military/defense strategy (the JCS); (3) operational utility (CINCs); (4) technological opportunities (technologists); (5) high level guidance (the President, Congress, Secretary of Defense); (6) non-DoD technology developments (e.g., industry, academia, etc.); and (7) prior year DoD S&T guidance, investment strategies, and programmatic assessments. The guidance should focus on three distinct time frames:

Near-Term - current capability upgrades;

Mid-Term - next generation capabilities; and

Far-Term - notional capabilities and new concepts.

The near- and mid-term time frames will provide for the exploitation of current technologies primarily by requirements pull while the far term seeks to develop both basic science and new technology. An effective and appropriately balanced emphasis on all three time frames provides an essential hedge against technological surprise and a more structured framework for the transition of technology to operational systems.

The DoD S&T Guidance should be based on the following factors:

1. Projected External Environment
   - geopolitical, economic, technological environments
   - projected threat
   - strategy modifications
   - manufacturing and technology base.
2. Operational Considerations
   - future war fighting environment
   - mission requirement changes.
3. Required Military Capabilities
   - near-term--provide technology for enhanced readiness and to fix deficiencies
   - mid-term--provide technology to improve effectiveness (e.g., performance, cost, supportability)
   - far-term--provide technology for new war fighting capabilities
   - Service unique capabilities (where appropriate).
4. National Level Thrusts
   - technology initiatives
   - inter-departmental coordination.
5. Other Considerations
   - industry research efforts
   - academic research efforts
   - foreign research efforts
   - off-shore migration of technology.

The DoD S&T Guidance should be developed by a group chartered by USD(A) and executed by DDR&E, and including representatives from all the Services and Agencies conducting science and technology programs, from JCS, the CINCs, and from the intelligence community. The guidance should be reviewed and approved by USD(A), who will then issue the DoD S&T Guidance to the Services and other DoD Agencies and direct them to develop coordinated investment strategies. This guidance document should also be used as input to the broader Defense Guidance issued by the Secretary of Defense and the more detailed operational objectives documents issued by the JCS.

Establishment of the first DoD S&T Guidance document will be the most difficult; thereafter, except for ad hoc policies and directives (e.g., training and education), the

guidance should not change rapidly from year to year unless there are sudden changes in the threat, national policy, funding, or technological opportunities.

c. The Service/Agency Investment Strategies

Upon receipt of the DoD S&T Guidance, the Service Secretaries and DoD Agency Directors should prepare specific guidance for their respective organizations. The Services and Agencies will then develop their individual S&T Investment Strategies in much the same way as in the current process, but with a consistent scope and guided by the DoD S&T Guidance. Each S&T Investment Strategy will then be presented to DDR&E for review. The Service/Agency Investment Strategies should focus on the same time frames as the DoD S&T Guidance:

Near-Term - current capability upgrades;

Mid-Term - next generation capabilities; and

Far-Term - notional capabilities and new concepts.

It is recommended that the S&T Investment Strategies address specific goals, with summaries of mission and technology areas and assessments of program risk. They should reflect coordination among the Services and Agencies and provide guidance to field activities regarding research and development and technology transition, including current and planned resources. The S&T Investment Strategies should contain discussions of the following areas:

1. Existing and projected war fighting environment
   - based on DoD S&T Guidance
   - Service specific.
2. Operational capability
   - mission impact
   - capabilities needed.
3. Broad system concepts
   - to meet war fighting options
   - to provide enhanced performance capabilities.
4. Key technology goals
   - permit system options
   - fill gaps in capabilities
   - exploit emerging technologies.

The technology goals described in (4) will be directed toward the operational capability and broad system concepts desired rather than toward programmatic detail.

d. OSD Investment Strategy Review

The Service/Agency S&T Investment Strategies should be reviewed by USD(A) to assure they are coordinated and consistent with the DoD S&T guidance. The investment strategies should be reviewed together, with mandatory attendance by high level representatives of all Services and Agencies. This will enable USD(A) to assure joint Service and/or Service/Agency programs, where appropriate, are initiated and any gaps or overlaps in the overall S&T Program are identified.

When satisfied that the individual investment strategies are coordinated, OSD should document this in a DoD S&T Investment Strategy document. The DoD Investment Strategy consists of the DoD S&T Guidance combined with the Service/Agency Investment Strategies and a summary chapter of the consolidated DoD Investment Strategy.

e. Measurement of S&T Planning Effectiveness by Feedback

The fundamental criterion for S&T planning effectiveness is the degree to which technology is made available to address shortfalls in military capabilities requirements. The major process for measuring effectiveness is contained in feedback from the program coordination process to the investment strategy, which is part of the review process shown in Figure III-1, above. This will illuminate progress by the Services and Agencies toward the planned goals set forth in the Investment Strategy. A direct measure of progress over time is the successful insertion of technology into operational systems.

f. The Benefits of Strategic Planning

If the planning process recommended above is effective, then:

- Instances of technological surprise will be infrequent, and hence major redirection in the S&T program will be infrequent.
- Little unwarranted duplication of research topics and facilities within and between the Services will be found.
- Planning for facilities, people, and missions should become easier, allowing laboratory efforts to stay focused on critical needs.
- S&T budgets and level of effort will be stable and consistent with Federal budget constraints and national military strategy.

- S&T advocacy by OSD and Congress will become stronger since the value of the S&T program should become more evident. S&T will also become more obviously integrated with the total RDT&E program.
- The time required for technology transition will be reduced and a greater fraction of S&T projects will make the transition to development programs.
- Centers of expertise in particular technology areas will develop as they gain intra- and inter-Service recognition for leadership in specific technologies.
- It will become easier to attract and retain highly talented scientists and engineers in needed disciplines due to the clear definition and stability of research missions.
- There will be an increase in the formation of stable defense laboratory/university/industry teams in specific technology areas with well-defined roles for each.

g. Timing

The strategic planning process must be carefully folded into the current PPBS (Planning, Programming, and Budgeting System) cycle in order to have any real impact. Consequently, the following schedules must be adhered to:

January	The DoD S&T Guidance is issued.
January-February	Service S&T Investment Strategies are prepared.
March	Service S&T Investment Strategies are reviewed.
March	The combined DoD S&T Guidance and DoD-wide Investment Strategy is issued.
January-May	Service and Agency S&T program formulation takes place. This process is continuously reviewed for consistency with the S&T Guidance and the Service Investment Strategies.

2. DoD-Wide Program Coordination

a. Outline of a Process for Improved Coordination

To effect an overall strategic planning process it is necessary to improve the programmatic coordination of S&T programs across all DoD Services and Agencies. It is recognized that some elements of the S&T program do have effective tri-Service coordination today, but in order for the Investment Strategy to be implemented, it is necessary to extend this coordination across all DoD S&T elements. This requires the

inclusion of other DoD Agencies in current coordination mechanisms and the extension of such coordination to all S&T technology areas.

There are formal tri-Service agreements on coordination of S&T programs in the medical area and in the chemical/biological area. There are also informal agreements covering the personnel/training and civil engineering areas. For the rest of the S&T programs there are a number of high level coordination groups, most established by the Joint Directors of Laboratories. Some of these JDL groups have proven effective while others have not; but they were never intended to carry out the formal coordination that is needed to support a strategic planning process.

In addition to these high-level groups, there are a multitude of other ad hoc tri-Service and inter-Agency coordination groups. The Task Force identified over 200 such activities (see Volume II, Working Group B Report, Appendix E). If a set of high-level Technology Coordinating Panels is established, then in the interests of efficiency these group activities should be reviewed to see where redundancies exist.

It appears that to strengthen the current coordination mechanisms the following steps need to be taken:

(1) Establish a DoD-wide S&T Coordination Group charged with establishing Technology Coordinating Panels (TCPs) for the whole S&T Program. In this process existing coordination mechanisms that are effective should not be replaced, but simply recognized as the official TCP for that area.

(2) Establish a common set of technology areas for the whole DoD S&T program. Each of these areas should have a TCP.

(3) Streamline the coordination process by absorbing or replacing existing groups that are not needed to support the work of the TCPs.

The programmatic coordination process that is envisaged is shown in Figure III-3.

b. The S&T Coordination Group

It is recommended that the S&T Coordination Group consist of senior representatives from all DoD Services/Agencies involved in S&T Programs, including but not limited to OSD, DARPA, DNA, and SDIO. The chairmanship of this group will rotate biannually among the Service and Agency members.

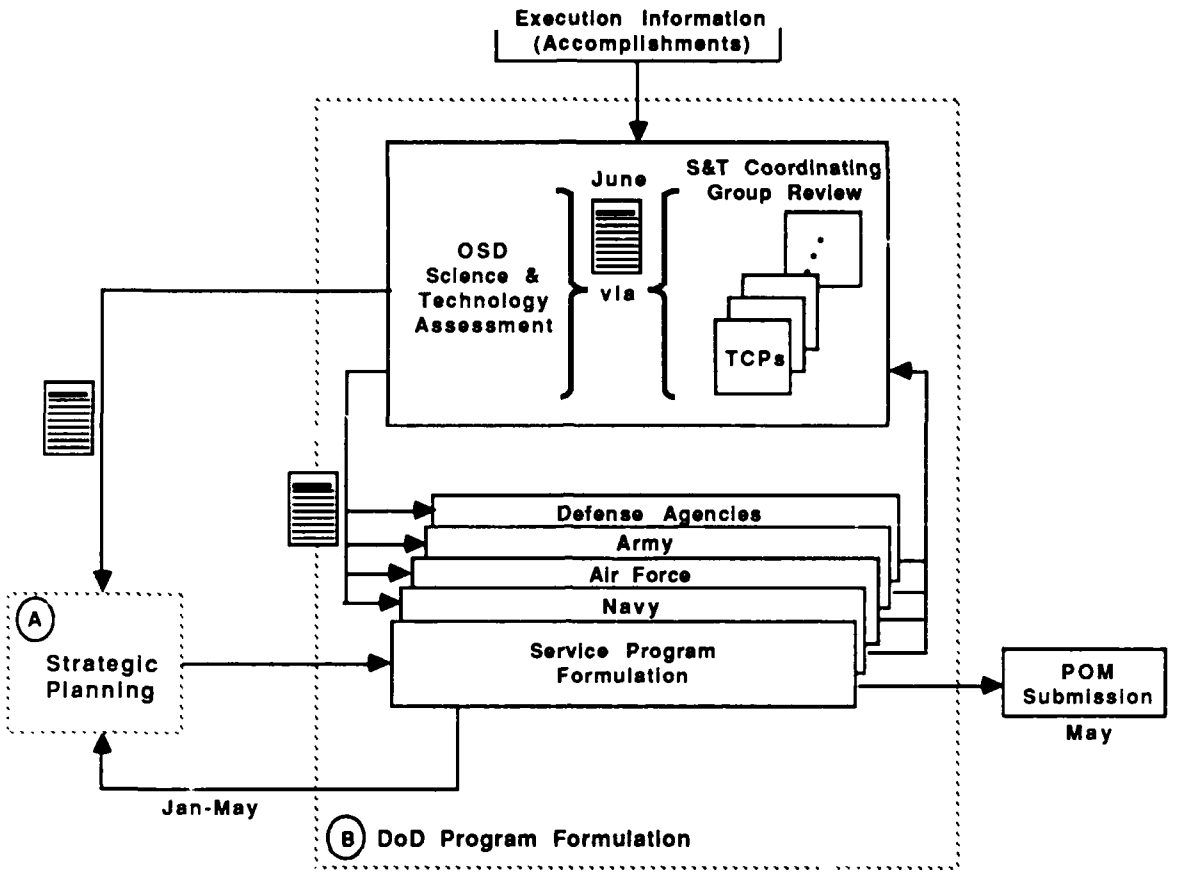

Figure III-3. Process for Coordination of Program Formulation

The S&T Coordination Group will have three primary responsibilities:

- Establishing the Technology Coordinating Panels (TCPs);
- Reviewing the reports issued by the TCPs and forwarding them to OSD; and
- Adjudicating disputes and ensuring efficient coordination of the TCPs.

One technology coordinating panel should be organized for each of the common technology areas proposed below (see Section 2[f]). These panels should be charged with preparing formal status reports (outlined in Section 2[d] below) for their technology areas. In preparing these reports the TCPs will use the existing data bases and formats that the Services use in their own planning processes. If new formats are required, it will be the responsibility of each Technology Coordinating Panel to develop the necessary formats under the guidance of the S&T Coordination Group.

The TCP members will be kept current with the status of the technology, why specific programs are being pursued, and what user needs necessitate pursuit of the technology. Specific technology roadmaps from the Services and other DoD agencies, by

common technology area, will be available to each Technology Coordinating Panel (TCP) for review. Specific programs, technical objectives and approaches, resource allocation by year, and where the technology flows and transitions occur will be included in these roadmaps. With this information, the following issues can be addressed:

- unwarranted technology duplication
- the resources being allocated by technology area, by Service/organization, and by year
- potential technology gaps
- identification of lead times for critical technologies for user needs.

The formal status reports prepared from these roadmaps for each technology area will enhance visibility of program changes, show technology slips/terminations due to budget reductions, and help to reduce year-to-year perturbations from changing priorities. These reports can also be accumulated at higher levels for investment analyses and advocacy to Congress.

c. Members and Chair of Technology Coordinating Panels

Membership on the TCPs for each technology area should consist of senior R&D managers in that area from each of the Services and the other DoD agencies. It is important that both DUSD(R&AT) action officers and Service Secretariat staff be members of the TCPs. Participation in the panels by DUSD(R&AT) action officers ensures that they will obtain first-hand knowledge of each technology area and satisfies the information dissemination function of an S&T Review. The DUSD (R&AT) action officers also have the opportunity to provide information during the TCP deliberations on coordination and review of the technology programs.

The chairperson of each TCP should serve a two-year term, with this as his or her primary responsibility, and the position should rotate among the Services (where appropriate). To be effective, the duties and authority of the TCP chairperson must not extend to directing programs and Service budget allocations, and should be defined as follows:

- To serve as the spokesperson and single focal point for the technology area, providing a ready access to information on that technology area
- To draw together and structure the top-level data to show that the technology area plan is integrated and that no unwarranted duplication exists

- To show applications for the technology area by mission area
- To articulate what technological advances are being pursued and why (e.g., evolving threats, Service needs)
- To articulate technology area plans and programs at an integrated level
- To facilitate actions to eliminate unwarranted duplication and assure critical mass resourcing
- To call meetings to review the technology area.

If issues (duplication, gaps, etc.) result from the meetings and cannot be resolved by the participants, these should be raised to the S&T Coordination Group for review and, if still unresolved, forwarded for review by OSD.

d. Output of the Technology Coordinating Panels

Each Technology Coordinating Panel will prepare an annual report on the status of its technology area. This report will discuss the development of the technology, how it is being coordinated, the significant milestones, and the shortfalls. This report will be completed by May 30 of each year and should contain the following sections:

1. Accomplishments

A listing of the accomplishments (significant technological breakthroughs).

2. S&T Strategy

A description of how the technology area fits into the DoD investment strategy goals and objectives.

3. Technology Roadmap

A time-based discussion of how the technology objective will be developed and an outline for feedback for accountability assessment.

4. Current Technology Program

A discussion of how the program is being developed and funded, showing how the Service and DoD agency programs are being integrated into the overall program, including future plans, and a revisit to the issues from prior years for providing feedback for accountability.

5. Shortfalls

Identification and discussion of unfunded emerging technologies and underfunded existing programs.

6. Issues

   a. Issues Solved

   b. Outstanding Issues

   Identification of coordination elements in disagreement and large-scale duplication

7. Competitive Technology Assessments

Discussion of the state of US technology (Industry, IRAD, etc.) in the area covered by the panel, and the state of the allies'/adversaries' technology.

8. Summary

e. Science and Technology Data Base

To have effective technical coordination of the S&T Program, S&T technical information must be available to the full DoD community in a timely manner. This may require the creation of a data base similar to that utilized for large weapon system development programs. The specification of this type of system is beyond the scope of this task force, but it is an important effort that should be undertaken. It is recommended that any development of an S&T data base include the Defense Technical Information Center and the Information Analysis Centers' participation.

f. Identification of Technology Areas for Coordination

The Task Force has identified a set of technology areas that covers the whole S&T program. In arriving at this list a compromise was sought among:

- The existing technology area divisions in the Directorate of DUSD(R&AT) (see Appendix B of the Report of Working Group B in Volume II).
- The existing subcommittees of the Joint Directors of Laboratories (see Appendix C of the Report of Working Group B in Volume II).
- The existing technology areas defined by the Services and Agencies, to the extent they were known by members of the Working Group.

They selected 17 technology areas are listed below. Some are Service unique, such as the Ships and Submarine or Tank and Automotive areas; others have assigned lead Service responsibility, such as Medical, Chemical and Biological Defense; others are of prime interest to all three Services and therefore should be areas of emphasis for

coordination. Some of the specific technologies comprising the technology area are listed for clarification.

Some of these 17 technology areas correspond to existing technology area structures. Medical, for example, is already covered by a Joint Service Agreement, as is Chemical and Biological Defense (see Appendix D of the Report of Working Group B in Volume II). Also, existing JDL coordinating groups on C^3I, EW, Advanced Materials, and Computer technologies appear to correspond directly to the proposed technology areas. Any list of standard technology areas will have to be reviewed periodically in conjunction with the goals and objectives of the DoD Guidance, and areas will have to be added to or removed from the list as required. The working group recommends that the S&T Coordination Group use the list below in establishing its TCPs, modifying it only as necessary. Note that the bulleted technologies are intended to be illustrative only and do not constitute a complete listing.

1. Chemical and Biological Defense
2. Environmental Science and Quality
    - Atmospheric
    - Terrestrial
    - Space
    - Oceanography
    - Hazardous and Toxic Materials
3. Materials and Structures
    - Structural Materials
    - System Materials
    - Non-Destructive Testing
    - Joining/Fabrication
4. Personnel and Training
    - Manpower and Personnel
    - Education and Training
    - Simulation and Training Devices
    - Human Factors
5. Ships and Submarines
    - Hulls
    - Hydrodynamics
    - Machining

6. Propulsion
    - Air Breathing
    - Rockets
7. Tank/Automotive
    - Armor
    - Power Plant
8. Aerodynamics and Controls
9. Weapons and Munitions
    - Conventional Munitions
    - Directed Energy
    - Chemical Weapons
10. Life Sciences
    - Life Support Systems
11. Civil Engineering
    - Airfields/Pavements
    - Quality Assurance
    - Facilities
12. Logistics
    - Material Supply
    - Distribution
    - Control
13. Surveillance, Reconnaissance, and C^3I
    - Communications
    - Control and Command
    - Navigation
    - Intelligence
    - Undersea
    - Space
    - Surface
    - Air
14. Electronic Devices and Avionics
    - Radio Frequency/Microwave/Millimeter Wave
    - Avionics
    - Control Components
    - Electrical Materials

15. Computers and Software
    - Software
    - Artificial Intelligence
    - Robotics
    - Architecture
16. Electronic Warfare
17. Medical.

g. Evaluation of Existing and Future Coordinating Activities

The objective of evaluating coordinating groups already in existence (or those which might be formed in the future) is to have the *minimum* number of coordinating groups required for providing information to each Technology Coordinating Panel for preparation of the formal report described above. The proposed process is as follows.

1. Each Technology Coordinating Panel establishes the number of technology sub-panels it requires to develop the information for its formal report. This process should include an evaluation of the existing coordinating groups on their capability to provide the information required. This process may also identify new technology sub-panels that may be required.

2. Each sub-panel in turn would evaluate the existing coordinating groups to determine the minimum number required to provide its information set. Again, the need may be identified for new coordinating groups or for the alteration of existing groups.

3. Existing coordinating activities examined by the processes in 1 and 2 above would be subject to the "One-by-One" Evaluation Approach in which the questions listed below are to be considered in evaluating each group. Findings and recommendations to disestablish a coordinating group would be forwarded to the agency or office that chartered that particular group.
    - Who established this coordinating mechanism?
    - Why was it established? Its purpose?
    - Is the purpose still valid?
    - What is its output?
    - Who receives its output?
    - Does the output support the process defined by Subgroup 1?
    - Is the output useful to those who receive it?
    - Who is the proponent of the mechanism?

- Who is responsible for abolishing the mechanism?
- What would not happen if this mechanism would be abolished?
- Could it be combined with another mechanism?
- When was its existence last reviewed?

4. Standardization and specification coordinating groups are excluded from this process, as are groups strictly devoted to technical exchange.

h. Timing

Service and Agency programs for a given fiscal year are formulated from January to May *two* fiscal years in advance (e.g., the FY91 budget goes to Congress in January of 1990, after having been formulated by the Services in January-May of 1989). During this period, the budgets should constantly be evaluated on the basis of their consistency with each Service's Investment Strategy--the result of the strategic planning process. In May, POMs/Program Objective Memoranda) are finally submitted. In June the Technical Coordinating Panels will report to OSD on the programs and progress in their technology areas. This information will then be incorporated into the next year's DoD Guidance, Investment Strategies, and program formulation process.

3. Advocacy

a. Overview

(1) Need to View S&T Program Costs as a Corporate Investment

The narrowing of the technological gap between the United States and the Soviet Union has potentially far-reaching implications for the US military posture. Reversing this trend must be seen as one of the main priorities of the Department of Defense in the years ahead. DoD's science and technology community can continue to provide the advances required for technologically superior war-fighting capabilities only if it is provided sufficient support from the higher management levels in DoD and in Congress. The long term value of investments in Science and Technology R&D must not be eroded by budget decisions in favor of more immediate short-term requirements. The relatively small amount of resources devoted to Science and Technology programs--less than 2 percent of the entire DoD budget--should be treated as a necessary cost of retaining superior war-fighting capabilities over the long term. S&T program costs must be viewed as an essential corporate investment.

(2) Need to Gain Better High-Level Support

Part of the advocacy problem that the S&T program faces is directly attributable to its small relative size, which, from a financial viewpoint, tends to make it a second order consideration. To offset this tendency, the fact that the S&T program is the cornerstone of future US technological superiority in its war-fighting capabilities needs to be constantly communicated to the senior decision makers in DoD. They in turn must become explicit and pro-active advocates of S&T program investments.

In order to support the senior decision makers' advocacy of the S&T program, they must be kept better informed of its objectives, accomplishments, and contributions. No one can be expected to support a program on faith alone. An additional benefit of providing such improved communication will be an increased emphasis on management and productivity improvements. The increased visibility will make S&T program managers more accountable for meeting the program objectives that have been set.

b. Recommendations

(1) Treat S&T As A Corporate Investment

- DoD should arrest the erosion of the current S&T program and establish and enforce rational goals for future growth. These goals should be established as a percentage of TOA, and not be subjected to trade-offs with other parts of the budget.

Implementation:

- OSD should establish an end-of-FYDP goal based on a coordinated DoD Investment Strategy, require annual growth to achieve this goal, and protect the S&T programs against disproportionate cuts during budget exercises. This can only be accomplished by the issuance of a directive signed by the Secretary of Defense.
- Pending issuance of this directive, the SecDef should ensure that the FY-90 S&T budget (exclusive of SDI) experiences positive real growth.

(2) Improve High Level Management Support for S&T

(a) Improve High Level Advocacy To Deliver Message

- The Secretary of Defense and other senior DoD decision makers should be explicit and pro-active in advocating the S&T program.

Implementation:

- USD(A) should personally provide highly visible advocacy for the S&T program
- Support of the S&T program should be articulated in all OSD, Service, and Agency posture statements.
- CINC and other user support must be cultivated by Service S&T program sponsors.
- USD(A) should direct that an annual review of the S&T program be given to the Defense Acquisition Board (DAB) by the chairman of the S&T Committee of the DAB.

(b) Improve Communication of Science and Technology Program Successes

- Science and technology program accomplishments and contributions should regularly be brought to the attention of senior OSD and Service decision makers, the CINCs, and Congress.

Implementation:

- Annual update by the chairman of the DAB S&T Committee to the DAB of S&T achievements relative to the S&T Investment Strategy, including the transitioning of technology to system application
- Unclassified DoD annual science and technology program report
- Publicize significant S&T results
- Encourage lab visits by Congressmen, DSB members, senior OSD and Service decision makers, etc.

(c) Improve Image of S&T Program Management

- Improvements in S&T Program management and other actions taken to increase productivity should be regularly brought to the attention of senior DoD and Congressional decision makers.

Implementation:

- SecDef should be periodically advised on S&T management issues
- Annual update to the DAB of S&T management improvements and ongoing actions by R&AT with Service support
- Publicize significant S&T management achievements, and include in an unclassified DoD annual S&T program report

Appendix A

LIST OF WORKING GROUP MEMBERS AND THEIR CHARTERS

LIST OF WORKING GROUP MEMBERS AND THEIR CHARTERS

A. WORKING GROUP A--LONG RANGE STRATEGIC PLANNING

Working Group A was established by the Core Group of the Task Force and provided with the following objective:

To improve the long range planning process and carry it to top management levels.

The specific issues this group was asked to address were:

1. What should be the OSD role in long range S&T planning?
2. How should Service long range S&T plans be coordinated?
3. What should a Service long range S&T plan contain?
4. How should the effectiveness of long range plans be measured?

The membership of the Working Group was selected by the Task Force to provide representation from all the relevant actors in the DoD S&T Program. A list of the members appears on the next page. The final report of Working Group A is contained in Volume II of this report. It completed its work over a five-month period, as the following schedule and outline of activities indicates:

29 February-01 March	Define issues, assign tasks
29-30 March	Review issues, outline report
25-26 April	Finalize progress report for Core Group
23-24 May	Prepare draft report
20-21 June	Review final report

Members of Working Group A

Mr. Donald L. Ciffone, Chief, Advance Systems Research Office, ARTA, Ames Research Center

Dr. Fred Diamond, Chief Scientist, Rome Air Development Center, U.S. Air Force

Mr. Gary Dubro, Deputy Director for Studies Analysis, ONT

Dr. Paris Genalis, Staff Specialist, IR&D, Emerging Technology, OUSD/R&AT

Mr. Al Goldstayn, Director of Plans & Programs, DCS Technology and Plans, HQ AFSC/XTX

Mr. Don Hart, Deputy Director, AFSTC/CV, Air Force Space Technology Center

Dr. John Harrison, Chief, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station

Dr. Paul Kurtz, Head, R&T Department, Naval Coastal Systems Center

Col. Carl E. Pedersen, Commander, U.S. Army Medical Materiel Development Activity, Fort Detrick

Mr. James Predham, DCS for Corporate Technology, LABCOM, U.S. Army

Dr. Stephen Sacks, Tech Base Manager, Naval Research Laboratory

Dr. Daniel N. Viccione, Center Manager for Tech Base Programs, Naval Underwater Systems Center

Dr. Billy Welch, Chief Scientist, Human Systems Division, HSD/CA, Brooks AFB

Mr. Doug R. Wilder, Manager of Commercial Business Analysis, IBM Federal Systems Division

Dr. Elihu Zimet, Director, AAW/ASUW/SAT Directorate, Office of Naval Technology

B. WORKING GROUP B--COORDINATION MECHANISMS

Working Group B was provided by the Core Group of the Task Force with the following objective:

> **To evaluate existing and new coordination mechanisms with a view toward improving coordination of programs and resources**

The specific issues this Working Group was asked to address were:

1. What coordination mechanisms should be used at OSD and Service levels?
2. How should bureaucracy be minimized in coordination efforts?
3. How should related S&T efforts be coordinated more effectively?
4. Can effectiveness of "mid-level" coordination be improved?

The members of this working group, selected by the Core Group of the Task Force, are listed on the next page. The final report of Working Group B is contained in Volume III of this report. Its schedule of meetings and activities were as follows:

02-03 March	Define issues, assign tasks
31 March-01 April	Review issues, outline report
27-28 April	Finalize progress report for Core Group
25-26 May	Prepare draft report
22-23 June	Review final report

Members of Working Group B

Dr. Budd B. Adams, Head, Exploratory Development Group, Naval Ocean R&D Activity, NSTL

Mr. James Burda Chief, Plans and Programs Division, AFATL/XP, Eglin AFB

Dr. James Bynum, Chief, Plans, Programs and Operations, U.S. Army Research Institute for the Behavioral and Social Sciences

Col. Harry G. Dangerfield, Executive Assistant to the PEO for Health Care Systems, Fort Detrick

Dr. Genevieve Haddad, Tech Director, Combat Support, DCS Technology and Plans, HQ AFSC/XTH

Mr. Dave LaRochelle, Chief, Plans and Programs Branch, Technical Plans and Operations, Air Force Geophysics Lab

Dr. John MacCallum, R&AT, Director, Electronic Systems Technology, OUSD/R&AT

Mr. William Noll, Staff Specialist, Laboratory Management Center, OUSD/R&AT

Dr. Lawrence J. Puckett, Associate Director, U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground

Dr. Richard Root, Assistant to Technical Director, Naval Ocean R&D Activity NSTL

Dr. Richard Schaffer, Technical Director, Construction Engineering Research Laboratory

Dr. Richard Sorenson, Deputy Director, Navy Personnel R&D Center

Mr. Glenn Spalding, Director, Support Tech Directorate, Office of Naval Technology

Mr. George Taylor, Associate for Technology and Engineering, Armament Engineering Directorate, ARDEC

Mr. Wilbert J. (Bill) Uhl, Air Force Wright Aeronautical Laboratory, Plans Office

Dr. Arno K. Witt, Technology Base Manager, Code 01B, Naval Air Development Center, Warminster, PA

C. WORKING GROUP C--ADVOCACY FOR S&T PROGRAMS

Working Group C was established as a subgroup of the Task Force Core Group. Many of its members were therefore also members of the Core Group (see the membership list on the next page). The Working Group had as its objective:

To improve the external and internal understandings of the importance of an efective S&T program in ensuring future war fighting capabilities

The specific issues this Working Group was asked to address were:

1. How should the S&T Program be presented internally and externally?
2. What supporting documents, facts, agencies should be used for S&T advocacy?
3. What methods could be used to improve the perceptions of S&T investment value?

The schedule of meetings and activities for this Working Group were:

9 February (Core Group)	Define issues, assign tasks
22 February	Address issues
9 March (Core Group)	Report back to Core Group
5 April	Prepare draft report
2 May	Review final report
3 June	Review final report

Members of Working Group C

Mr. Brett Able, Special Assistant to the Deputy Under Secretary of Defense for Research and Technology (OUSD/R&AT)

Dr. Gary L. Denman, Deputy Director, Air Force Wright Aeronautical Laboratory, Wright-Patterson AFB

Col. Joseph Denniston, Executive to the Assistant Surgeon General for Research and Development, Department of the Army

Dr. Hamed El-Bisi, Deputy Director, Army Research & Technology (Research & Laboratory Management), Office of the Assistant Secretary of the Army for Research, Development and Acquisition

Mr. Michael Flynn, Technical Advisor, Directorate for Science and Technology, SAF/AQT

Mr. Bruce Fonoroff, Director, Technology Planning and Management, LABCOM, U.S. Army

Col. James M. McCormack, Assistant Deputy Chief of Staff, Technology and Requirements Planning, Air Force Systems Command

Mr. Robert Moore, Deputy Director, Office of the Chief of Naval Research, Office of Naval Technology

Mr. Raymond F. Siewert, Director, Engineering Technology, OUSD/R&AT

Mr. Marshall John Tino, Associate Technical Director, Naval Surface Warfare Center

Dr. William M. Tolles, Associate Director of Research for Strategic Planning, Naval Research Laboratory

Appendix B

IMPLEMENTING MEMO

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301

ACQUISITION

(R&AT)

5 NOV 1987

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT & ACQUISITION)
ASSISTANT SECRETARY OF THE NAVY (RESEARCH, ENGINEERING & SYSTEMS)
ASSISTANT SECRETARY OF THE AIR FORCE (ACQUISITION)

SUBJECT: Improved Coordination of DoD Science and Technology Programs

The potential impact of tighter budget constraints on the technology base makes it imperative that the Department of Defense be able to effectively coordinate the technology programs at dozens of separate laboratories and RDT&E centers, and justify to Congress the levels of funding needed for successful efforts at these facilities. In order to ensure that Science and Technology (S&T) resources are allocated efficiently--whether they are cut, maintained at present levels, or increased--improved methods of coordination among the DoD labs must be developed.

I am chartering an ad hoc task force under the auspices of the Institute for Defense Analyses to develop a strategy and implementation plan for improving the coordination of resources and responsibilities among the DoD laboratories with emphasis on strategic planning. The study will identify the laboratory community's overall objectives, outline the major steps needed to accomplish them and recommend the means of implementation.

I would like each Service to appoint a senior representative to this ad hoc group and provide support personnel from laboratories characteristic of the main stream S&T activities in each Service. At the completion of the Task Force's work, I will arrange for briefings to senior Service and DoD personnel.

The point of contact in my office for this effort is Mr. Brett Able. Please provide the names of your representatives to Mr. Able (697-9001) within two weeks.

Ronald L Kerber

Ronald L. Kerber
Deputy Under Secretary of Defense
(Research and Advanced Technology)

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, DC 20301-3010

5 FEB 1988

(R&AT)

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT & ACQUISITION)
ASSISTANT SECRETARY OF THE NAVY (RESEARCH, ENGINEERING & SYSTEMS)
ASSISTANT SECRETARY OF THE AIR FORCE (ACQUISITION)

SUBJECT: Improved Coordination of DoD Science and Technology Programs

I have the same concerns about the need for improving the coordination of the S&T programs across all of DoD as were expressed by Dr. Kerber in his November 5, 1987, memo to you. In that memo he chartered the Institute for Defense Analyses to form an ad hoc task force to address this issue and asked for your support of the effort by providing appropriate membership.

I consider the work of this Task Force important to DoD and have decided to assume its sponsorship so that Dr. Kerber's departure will not have any adverse effect on its momentum. The first meeting of the Task Force was held in late January. I consider the issues addressed by the Task Force and outlined in the initial meeting to be highly important and solicit your continued support for this effort.

Robert C. Duncan

Attachment

Appendix C

RESULTS OF PREVIOUS STUDIES OF THE DoD LABORATORIES

RESULTS OF PREVIOUS STUDIES OF THE DoD LABORATORIES

The Task Force has identified at least 22 studies of the S&T Program which have been conducted by DoD over the last 25 years. This appendix contains excerpts from three of those studies. Section A contains excerpts from the 1987 Defense Science Board *Summer Study on Technology Base Management*. Section B reproduces the executive summary from the 1982 "Hermann" study, *OUSDRE Independent Review of DoD Laboratories*. Section C contains an extract from the 1981 "Heilmeier" report, *Report of the Defense Science Board 1981 Summer Study Panel on the Technology Base*.

Very few of the above studies contain recommendations which are of significance or relevance to this Task Force's efforts. The primary concern of most studies has been with management structure, personnel, contracting, and other issues that are encountered by the DoD laboratories. In other words, most studies have concentrated on how the management and efficiency of the labs could be improved, as distinct from the overall program of activities undertaken by the laboratory community. Where the technical program has been addressed it has usually been to recommend specific areas for emphasis.

The 1987 DSB *Summer Study on Technology Base Management* included a review of 16 prior studies of the science and technology program. The recommendations contained in those studies were categorized according to a number of management areas:

- Science and Technology Strategy
- Personnel
- Management and Organization
- Funding
- Peer Review and Performance
- Facilities and Equipment
- University/Industry/Service Interaction

- Technology Transfer
- Contracting.

The matrix reproduced on page C-9 indicates which of these 9 issue areas were adressed in each of the 16 studies.

Science and Technology strategy--the subject of the Task Force--was addressed by only six of the studies reviewed, including the Hermann and Heilmeier reports. The view of Science and Technology strategy taken in those reports, however, was not as broad as that taken by this Task Force. For example, as a result of the recommendations in those studies, a number of actions were taken, including the following:

- Logistics R&D was strengthened.
- The 6.3A Technology Demonstration Program was created.
- The Heilmeier "Top 17" Technologies List was used to guide investment.
- Lead laboratories were established for several selected technologies.

The primary goal of all these recommendations was to guide the Science and Technology Program, or portions of it, in a particular direction. In other words, they urged the adoption by DoD of a particular strategy for a particular segment of the program. The premise of this Task Force's effort is that it is not enough to state the need for a strategy, or to suggest that a particular strategy be adopted. Success in any organization requires that a *permanent process* be established for the development and execution of that organization's strategy. That process must ensure that the organizations detailed "sub-strategies" are consistent with its overall strategy, and that this overall strategy, in turn, *meets the organization's ultimate goals and objectives.*

A. EXCERPTS FROM THE 1987 DEFENSE SCIENCE BOARD *SUMMER STUDY ON TECHNOLOGY BASE MANAGEMENT*

EXECUTIVE SUMMARY

This report presents the results of the 1987 DSB Summer Study on Technology Base Management. This study focused on two issues:

- Is the Technology Base efficiently producing technology options adequate in number and quality for DoD users and operators?
- How can the transition of new technology to the field be accomplished most effectively?

There have been many studies of the Technology Base over the past fifteen years; these studies have come to conclusions similar to those of this Study Group and made similar recommendations. This Summer Study has relied heavily upon these prior reports and we have attempted to formulate our recommendations in a manner that will improve the chances of implementation.

The new circumstances which justify a new Technology Base study at this time are:

- The growing perception of a diminishing margin of U.S. technological advantage.
- The concern that the DoD is receiving less value for its R&D dollar.
- A growing appreciation for the overlap between technology advances in the commercial and defense sectors.
- The major reorganization of the DoD Acquisition System which is underway.

The Study Group focused its attention on the management of the Technology Base and the process by which resource allocation decisions are made. Our concern was how efficiently available resources are being deployed; we did not examine the adequacy of the present level of resources. Since no precise objective estimates are possible for the performance of the Technology Base, the Study Group relied upon its judgment of the strengths and weaknesses of the existing program in reaching its conclusions and recommendations.

Management of Research

Over the long term, the leadership and vitality of the U.S., both economically and militarily, depends extraordinarily on the quality and vision of our program of basic research. It is essential that this central tenet be understood and endorsed at the highest levels of our national leadership. The Study Group concurs with a widely held perception and concern that our national technological advantage has eroded significantly in recent years. Even recognizing the growth of other government research activities, the size and performance of the DoD 6.1 research program has not kept pace with scientific opportunities and needs related to defense interests.

Where once OSD exerted a centralized point of unified leadership and budgetary authority and control for the 6.1 program, the Study Group is concerned that this leadership is fragmented by too much delegation to the Services and agencies; the 6.1 program has, in effect, been relegated to a position of second order importance and lacks top management attention.

Technical Management and Laboratories

This nation has long been well served by defense laboratories in innovative research and in the support of national emergencies. These contributions have resulted largely from the quality of the scientists and engineers at these laboratories, together with the leadership, resources and organizations supporting them. The quality of the laboratories and their technical leadership are of supreme importance to DoD. Given the current circumstance of many DoD laboratories, and the belief that current problems will likely worsen in the future, the focus of this Study Group was on formulating recommendations which could increase the effectiveness and continuity of DoD laboratories.

The Study Group also focused attention on the technical competence of the personnel who direct and manage our technology program. We formulated recommendations which will upgrade significantly the technical management skills available within DoD for management of its technology base programs.

Technology Transition

Present and past national research and exploratory development programs have demonstrated an abundance of innovative ideas within the U.S. scientific and engineering communities. However, the Study Group believes that both the Defense Department and commercial industry are seriously deficient in rapid technology transition from R&D to systems and products. This situation is a primary contributor to the growing crisis in military competition as Soviet weapons system performance approaches and, in some cases, exceeds that of U.S. and Allied forces.

The Study Group concluded the greatest opportunity to improve the rate and effectiveness of this transition process is by increasing focus on the early advanced development phase of the S&T program, that is, Budget Category 6.3A. In order to overcome the barriers to effective transition the Study Group believes that DoD should strengthen and employ its 6.3A program to emphasize the careful selection and timely execution of system and major subsystem Advanced Technology Transition Demonstrations to build and test experimental systems in a field environment.

Other Central Important Issues

The Study Group also discussed several other topics which we believe to be important to DoD on Technology Base:

- International Technology Base Cooperation
- Dual Use Technology and the Technology Base
- Contracting for Technology Base R&D
- Biomedical R&D
- Microelectronic and Optoelectronic Production Start-Ups

These issues are discussed in the attached report.

Recommendations

For the DoD basic research program, the Undersecretary of Defense (Acquisition) should delegate his Acquisition Executive function to an individual within his staff. This individual should be vested with full authority and responsibility for the 6.1 program. Specifically:

> *USD(A) should restate the purpose and mission for the 6.1 program of basic research and explicitly reaffirm its importance, emphasizing its long-range focus.*
>
> *USD(A) should explicitly recognize the 6.1 program as an integrated corporate program and should re-assert the corporate budget and managerial authority already resident within OSD.*

For improving the DoD laboratories, three recommendations are made. The first two recommendations outline DoD-wide changes. The third recommendation suggests demonstration projects which embody more radical changes.

> *USD(A) should take immediate positive action to expand the NOSC/NWC (China Lake) personnel experiment to encompass all DoD laboratories for all scientists and engineers (S&E's). In addition, necessary changes in law and regulations should be made to extend the probationary period for laboratory S&E hires from one year to three years.*
>
> *USD(A) should direct that the individual Services establish a clear line of responsibility, authority and accountability to each laboratory/technical director and that these laboratory/technical directors be appointed for five years, renewable upon review.*
>
> *USD(A) direct each Service to create at least one demonstration laboratory project which attracts and retains highest quality staff; improves contracting effectiveness; improves personnel management; and provides local laboratory management authority and accountability.*

To improve the quality of personnel involved in the management of the DoD Technology Base, the Group recommended another demonstration project.

> *USD(A) should establish an experimental Senior Scientific Technical Acquisition Executive Program. This initiative would consist of up to 100 non-tenured appointments within DoD with the goal of significantly strengthening critical technology skills, Technology Base management, and Defense Acquisition management. Compensation for such non-tenured employment would be based on comparability. Legislative action would be required to permit the appointees to return to their positions at the end of their appointments.*

The transition of militarily cost effective technology from R&D to the field was the issue of greatest concern to the Study Group. The Study Group notes that the 6.3A budget category is key to this transition if properly utilized to facilitate the technology transition. The Study Group recommends that the 6.3A activities be refocused by the establishment of a program of Advanced Technology Transition Demonstrations (ATTD's).

USD(A) employ 6.3A for ATTD projects to sharpen DoD's focus on technology transition.

- *Building and testing experimental systems in field environment to establish technical feasibility and field utility before a system commitment and Full Scale Engineering Development (FSED) decisions are made.*
- *Use specific management principles to guide those projects.*
- *Direct (by FY91) half or more 6.3A funding to ATTD projects -- approximately $1B (in FY 1988) or 2-1/2% of RDT&E (do not use 6.1 or 6.2 funds).*
- *For all ATTD projects request Vice Chairman JCS to review annually to assure projects address future military user needs.*

Annex D

AN OVERVIEW OF PAST STUDIES OF THE DoD SCIENCE AND TECHNOLOGY PROGRAM

Introduction

This annex summarizes substantive recommendations and resulting actions of sixteen prior studies of the DoD Science and Technology program. The studies reviewed here occurred since 1966 and focused on the planning, management, coordination and execution of the program and on the relative importance of its technical area components. These do not include studies of individual technologies or individual Service or Defense Agency studies of their program components.

Figure D-1 lists the reports reviewed. All were performed by high-level committees or task forces functioning under the auspices of the White House Office of Science and Technology Policy or the Office of the Secretary of Defense. The task forces included many expert individuals renowned in science and technology. These reports have been prepared in response to a need or a problem perceived by the sponsoring office and all seem to have been done with a sense of urgency thus indicting the degree of importance.

The recommendations of these many studies can be categorized by the following technology base management areas: Science and Technology Strategy; Personnel; Management/Organization Initiatives; Funding; Peer Review/Performance; Facilities and Equipment; University/Industry/Services Interaction; Technology Transfer; and Contracting. Each area is discussed below. Figure D-2 shows the linkage between these areas and the reports reviewed. Note that some of the reports, such as the Packard and Hermann reports, were very broad ranging, whereas others were much more narrowly focused.

Science and Technology Strategy

Many of the studies addressed the allocation of priority and funding to the various technologies in the Science and Technology Program. The recommendations stressed closer consideration of operational needs in planning, the adoption of a modernized technology investment strategy, and the designation of lead laboratories for specific technologies. Joint planning in defined areas and the creation of vertically integrated programs with fenced funding were also recommended. Closer interaction between DARPA and the Services was recommended as a catalyst for joint planning. Specific programmatic recommendations included strengthening logistics R&D programs and establishing R&D centers in simulation, electronic warfare, and C3. Several reports over the years recommended expansion of the 6.3A Advanced Technology Demonstration Program.

As a result of these recommendations, logistics R&D was strengthened, and the 6.3A Technology Demonstration Program was created in 1975 and increased to $1.7B in 1987. The Heilmeier "Top 17" Technologies List was used to guide investment. Lead laboratories were established in several select technologies. The Forecast II, Air Land Battle Environment, and Army 2000 are examples of studies performed to link operational needs to planning and to guide technology investment. Finally, the VHSIC and MMIC programs are examples of vertically integrated programs that utilize "fenced" funding.

TITLE	AUTHOR	DATE
Report on Finding Recommendations	FCCSET Funding Working Group Chaired by R. Oswald	May 1984
President's Private Sector Survey on Cost Control	R&D Task Force Co-Chaired by David Packard	December 1983
Federal Laboratory Review Panel	White House Science Council's Federal Lab Review Panel Chaired by David Packard	May 1983
USDRE Independent Review of DoD	Robert Hermann	March 1982
Report of the Defense Science Board Task Force on University Responsiveness to National Security Requirements	DSB Task Force Chaired by Ivan Bennett	January 1982
Report of the Defense Science Board 1981 Summer Study Panel on Technology Base	DSB Study Chaired by George Heilmeier	November 1981
Report of the DoD Laboratory Management Task Force	Arden Bement	July 1980
A R&D Management Approach: Report of the Committee on Application of OMB Circular A-76 to R&D	FCCSET Committee Chaired by Gerald Griffen	October 1979
Institutional Barriers on DoD Laboratories	Service Senior Laboratory Reps	October 1979
Report of the Acquisition Cycle Task Force Defense Science Board 1977 Summer Study	Acquisition Cycle Study Chaired by Dick DeLauer	March 1978
DSB Task Force on Federal Contract Center Utilization	DSB Task Force, Chaired by Robert Duffy	February 1976
DoD Medical and Human Resources Laboratory Utilization Study	John McCambridge and Stanley White	September 1976
DSB Summer Study Task Force on Technology Base Strategy	DSB Study, Chaired by Normal Rasmussen	September 1976
DoD Laboratory Utilization Study	John Allen	April 1975
Task Group on Defense In-House Laboratories	Task Group Chaired by Edward Glass	July 1971
DoD In-House Laboratories	DSB Task Force Chaired by Leonard Sheingold	October 1966

Figure D-1: Reports Reviewed

	S&T Strategy	Person-nel	Mgmt. & Org.	Funding	Peer Review	Fac. & Eqpmt.	Univ/Ind/ Services	Tech Transfer	Contract-ing
FCCSET Funding Grp Rprt 1984				X					
Grace Comm. R&D Tsk Fce Rprt 1982/83		X	X				X		
Packard Report on Fed Labs 1982/83		X	X	X	X			X	X
Hermann Report 1981/82	X	X			X	X	X	X	X
Bennett DSB 1981/82				X		X	X		X
Heilmeier DSB 1981	X	X	X	X		X	X		X
DoD Lab Mgmt Tsk Fce (Bement) 1980			X			X			X
Griffen FCCSET 1979			X						
Institutional Barriers (Davis) 1979		X	X						
DeLauer DSB 1978									X
Duffy DSB 1975/76			X						X
McCambridge/White 1975/76	X		X	X					
Rasmussen DSB 1976	X		X	X					
Allen 1974/75	X	X	X	X					
Glass Report on In-House Labs 1971	X	X	X						X
Sheingold 1966			X						

Figure D-2: Linkage Between Areas Studied and Reports Reviewed

Personnel

Most of the studies made major recommendations in the personnel area, including recommendations to define each laboratory's mission, to select very well qualified individuals as Laboratory Director -- whether military or civilian -- and give him the responsibility, flexibility, and authority to perform the mission and "hire and fire." Surprisingly, the studies made few specific recommendations concerning the quality of laboratory personnel at other than the director level. The studies also recommended creating a separate scientist and engineer personnel system and that the Naval Ocean Systems Center and Naval Weapons Center (China Lake experiment) personnel management technique be implemented DoD wide.

Over the past several years, there has been concerted action on the part of OSD and the Services to improve the "personnel system." To date, however, few significant changes have occurred. There has been a trend toward selecting the best qualified person (military or civilian) to be the laboratory director. However, there appears to be a continued requirement for sufficient tenure to assure scientific program stability.

Management and Organization

Almost all the studies made recommendations to improve Technology Base management and organization. Major recommendations included initiatives to: give laboratory directors more authority and responsibility, streamline the organizational structure of the Technology Base, and raise productivity. In the latter case, productivity would be raised by achieving a better balance of the Technology Base program across performers; by adopting a more cooperative and efficient use of human and material resources; and by reducing the number of audits, inspections, and reviews. Finally, there were recommendations to establish advisory groups that would provide independent advice to SPO directors, to increase laboratory participation in weapon system planning, and to endorse DoD's FFRDC Policy.

These recommendations have resulted in a better balancing of in-house laboratory manpower, the confirmation of continued FFRDC operations, and the provision of Technology Base advice in the Defense Acquisition Board process.

Funding

Higher funding of the Technology Base is a perennial concern of many of the studies. These recommendations are generally expressed as a need for increased funding levels in several specific technologies, as in the Heilmeier Report, or for various "causes," as in the Bennett Report on University Responsiveness. The Packard Report of 1982 and the FCCSET Funding Group Report of 1984 recommended that funding be appropriated for research and development on a predictable two-year basis so that staffing levels and research activities at federal laboratories can be more optimally planned.

DoD and Congress are moving closer to adopting a two-year budget cycle. Funding for various high priority technologies has been increased. Funding levels in the 6.1 and 6.3A programs are increasing; 6.2 funding has remained level.

Peer Review and Performance

Little was said about the peer review process and resulting performance. The Packard Report viewed current oversight procedures as requiring an excessive amount of reporting

and paperwork (stressing measurable criteria such as time and cost), but providing inadequate scrutiny of the quality and relevance of the laboratories' activities. The Packard Report recommended that the competitive peer review process for funding basic research be further adopted to ensure quality and relevance of research.

As a result of the Packard Report, additional peer review panels have been formed by the DoD laboratories.

Facilities and Equipment

Some of the more recent studies noted the need for modernization of facilities and equipment. Providing better university and industry access to laboratory facilities, as well as upgrading university equipment, are two high priority recommendations. The DoD Laboratory Management Task Force report of 1980 (Bement Report) recommended the establishment of in-house laboratory facility and equipment modernization policies whose funding totaled about $300 million per year. Finally, there were recommendations to provide flexibility by raising laboratory director funding authority for facilities and equipment.

The DoD University Research Instrumentation Program was created as a result of previous study recommendations. This program, initiated in FY83, provides $150 million over five years for university research equipment. The Bement Report recommendation for the establishment of in-house laboratory facility and equipment modernization policies has not been implemented.

University Industry/Service Interaction

A number of studies noted the dependence of a healthy Defense Technology Base upon the interaction and cooperation of the Services with the R&D community in the university and industry sectors. Supporting recommendations included creating additional university-based centers of R&D excellence, awarding additional graduate fellowships, establishing a DoD-University Forum, and continued effort to resolve the tension between the advantages of open scientific communication and the imperatives of national security.

Over the past few years, many of these recommendations have been acted upon. Industry interaction with universities was made a factor in determining IR&D ceilings. A DoD-University Forum was created to foster a dialogue with universities. A DoD-University Research Initiative and an instrumentation program were established. Funding to universities was increased. A scientific paper review and publishing policy was formulated to lessen the dilemma of open scientific communication and national defense imperatives.

Technology Transfer

There were major concerns over the inadequacy of the flow of knowledge from the laboratory to the field and from universities to government/industry and vice versa. Most recommendations were stated broadly and included provisions for collaborative projects as well as increased exchange of knowledge and personnel between DoD, universities and industry.

These recommendations are partially implemented in the Federal Technology Transfer Act of 1986 which encourages the use of Federal government developed technology by state and local governments and by the private sector.

Recommendations on the broad subject of contracting have become prominent in recent studies. Seven of the last eight studies expressed a desire to streamline procurement practices. The prime concern has been the length of the procurement process which adds cost and substantially delays the development of new technology. The major recommendation was to treat science and technology procurement differently from other procurement.

Another specific recommendation was the need to raise the "Determination and Findings" (D&F) limits. This is the dollar ceiling, which if exceeded, requires Service Secretarial approval prior to contracting. Raising the ceiling would provide laboratory directors more latitude and reduce the administrative burden of reapproving procurements. Some streamlining of the contracting process has been provided for the 6.1 and 6.2 programs. Though not fully implemented, the D&F limit has been raised to $1 million.

The Competition in Contracting Act (CICA) initially created significant unintentional delays in Technology Base contracting; however, recent interpretations of CICA are easing contracting for 6.1 and 6.2 efforts.

Summary

Several recommendations have led to actions taken to address the particular situation in question. Significant steps have been taken to provide proper balance among the various Technology Base performers (in-house laboratories, universities, industry, and FFRDCs) and to stimulate greater interaction between DoD and universities. A separate budget category, 6.3A, was established in 1975 for Advanced Technology Demonstrations and has grown to nearly $2B (excluding SDI) in 1987. Formal peer review processes have been established. Two-year budget cycles may be implemented in the 1988-89 budget cycle.

Several recommendations remain open to further action. The Technology Base organization and management structure and contracting practices need to be streamlined. A number of recommendations have not been implemented: to select the "best qualified" laboratory directors (military or civilian), to provide programmatic stability, to give more authority and responsibility to laboratory directors, to create a separate personnel system for scientists and engineers, to designate lead laboratories with specific missions, and to pursue joint service planning.

B. "HERMANN" REPORT

Reproduced here is the Executive Summary of *OUSDRE Independent Review of DoD Laboratories* by Dr. Robert J. Hermann, 22 March 1982.

On 3 September 1981, Dr. Richard Delauer, Under Secretary of Defense for Research and Engineering, established a review of Department of Defense laboratories. This review was undertaken by Dr. Robert Hermann, under the direction of Dr. Robert Cooper, with the assistance of representatives of the Army, Navy, Air Force and DARPA.

The study team found:

- There is indeed a strong and continuing need for the DoD to maintain the Laboratories and R&D centers.
- Much good work is being done in the laboratories and technology created by the laboratories continues to make its way into the operating forces.
- There really are several fundamental problems involving laboratory performance and laboratory relationships with the ultimate user community.
- There exists a disconnect between the laboratories and the Operating Forces which exacerbates the problem of technology transition to the field.
- Industry, the laboratories, and the user community all feel cheated by the existing process.
- The time is ripe for improving the DoD/University R&D connection.
- There are new technology opportunities and technology based operational functions, which have evolved in recent years, which require special DoD attention to realize the maximum benefit.
- The technology environment surrounding the laboratories has dramatically changed in recent years, which requires that DoD and the Services reassess the laboratories' roles and missions.

The study team recommends:

- That the USDRE initiate action to upgrade laboratory personnel practices. Special recommendations are included in the report.
- That the USDRE support initiatives to streamline the procurement process, which is viewed as a major deterrent to the laboratories' efficient operation and innovation process.

- That the DoD modestly increase the rate of modernization of facilities ($70M per year per Service for the next 10 years) and equipment ($25-30M, per service per year for the next 10 years).
- That the USDRE support the goal of improving the DoD/University connection (six individual recommendations are included).
- That the USDRE support the establishment of an External Advisory group for each laboratory.
- That the USDRE support the establishment of an outside, expert review process which would assess each laboratory's effectiveness every three to five years.
- That the USDRE initiate appropriate action to improve industry's visibility of laboratory activities.
- That the DoD undertake the initiation of a formal process to develop operational concept projections to provide scenarios of future military operations. This document should unify the various Service perceptions, and then be used by the laboratory community to guide their respective technology developments.
- That the USDRE undertake a new approach to coupling the laboratories with the Operational Forces by providing the Unified and Specified Commands and subordinate component commands with modestly sized technical staffs, drawn from the DoD laboratories.
- That the USDRE task each military department to establish a formal "Logistics R&D Program." It is perceived that this area of R&D consistently receives inadequate attention by the Services.
- That the USDRE support the expansion of critical demonstration programs by providing the ASD(RT) with a $300-400M set-aside.
- That the USDRE form a special task group to examine the optimum mechanism for establishing a new Center for Micro-electronics and Computer Sciences.
- That the USDRE support the expansion of the Joint Electronic Warfare Center (JEWC) in San Antonio, TX, to strengthen the DoD capability to develop and apply new electronic warfare techniques; to focus on joint and combined technology-operational techniques; and to conduct test and evaluation.
- That the USDRE support the establishment of a formal Command and Control Research Program and Center, which is consistent with the DSB report of 1978 on C^3 acquisition.

Further amplification of each of the above recommendations is included in the report.

C. "HEILMEIER" STUDY

Reproduced here is an extract from *Report of the Defense Science Board 1981 Summer Study on the Technology Base.*

REVIEW OF PAST STUDIES RELATED TO THE DoD LABORATORY/UNIVERSITY ISSUE

1. Make the overall research strategy less vulnerable to changing environmental influences (e.g., Congressional mood swings).

   Reports where these recommendations appeared: A, C, E, G, I, K, S.*

2. Improve communication/cooperation between DoD in-house laboratories and the general research community.

   Reports where these recommendations appeared: C, D, E, G, H. J, K, M, S.

3. Shift the ratio of intramural to extramural research toward outside contracts and/or increase the percentage of university/small business basic research.

   Reports where these recommendations appeared: B, C, F, K, M, T.

4. Increase block funding to basic research programs (both out-/in-house) in order to maximize innovation and permit flexibility.

   Reports where these recommendations appeared: B, C, F, G, K, S, T.

5. Establish a review mechanism for university, contractor, and in-house research programs that bases further funding on the quality, productivity, and impact of the research.

   Reports where these recommendations appeared: A, C, E, G, H, I, K, M, T.

6. Remove the "albatross" of relevancy from the necks of researchers (both intramural and extramural) in order to free scientists/engineers from the limiting effects of such constraints. Make the criteria of relevancy apply to broadly defined fields and disciplines rather than to an individual program area.

   Reports where these recommendations appeared: C, D, G, H, K, M, T.

7. Overcome the "inertia to change" evident in some DoD in-house laboratories (which inhibits progress towards more advanced technologies) by simplifying the complicated, layered management structure.

   Reports where these recommendations appeared: A, B, C, F, G, H. I, K, S, T.

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* See Key on second page for referenced reports.

8. Enhance the quality of the research in in-house laboratories by improving the position of in-house scientific personnel:
   - Make salary/benefits competitive with industry
   - Make career options more promising/stable
   - Do not subject quality technical personnel to the vagaries of budget management nor to the public disclaim accorded all civil service workers.

   Reports where these recommendations appeared: A, C, E, H, I, J, L, T.

9. Avoid the trend toward over-burdened, overly comprehensive (full spectrum) in-house laboratories. Consolidate and focus the research and eliminate diversification at the laboratories and/or FCRCs.

   Reports where these recommendations appeared: A, B, D, F, G, H, T.

10. Increase the amount and timeliness of DoD implementation of high quality, front-line, capital equipment at facilities (both out-/in-house).

    Reports where these recommendations appeared: C, H, K, L.

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Appendix D

CURRENT OTA STUDY OF S&T PROGRAMS

CURRENT OTA STUDY OF S&T PROGRAMS

A recent publication or the Office of Technology Assessment, *The Defense Technology Base -- Introduction and Overview*, has findings remarkably similar to those of this Task Force.* Chapter I of that study, "Introduction and Principal Findings," is reproduced on the following pages.

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* U.S. Congress, Office of Technology Assessment, *The Defense Technology Base, Introduction and Overview--A Special Report*, OTA-ISC-374 (Washington, DC, U.S. Government Printing Office, March 1988).

Chapter 1

Introduction and Principal Findings

WHY BE CONCERNED?

For roughly three decades, U.S. national security planning has rested heavily on the premise that superior technology can offset Soviet advantages in numbers of military personnel and major military equipment. But in the past few years there has been mounting concern that the United States is not maintaining the necessary technical lead. If the United States cannot maintain a meaningful technological lead and there are no fundamental changes in the competition between the two superpowers, the nation will be faced with a choice among accepting a significantly decreased level of security, relying more heavily on our allies, or making major increases in the size of its armed forces.

There are several ways to assess a technological lead, but in defense the most important indicator of technological advantage—perhaps the only one that ultimately matters—is the technological lead in fielded military equipment. Wars are not fought or deterred by engineering drawings, but by existing forces.[1] However, major technical advances that are still under development can have profound effects on superpower relationships, as the Strategic Defense Initiative (SDI) has illustrated.

Maintaining a technological lead in fielded military equipment is a far more difficult task than catching up.[2] It requires a dynamic, creative, and innovative technology base, as well as an efficient industrial structure that can rapidly translate technical developments into meaningful numbers of effective products in the field. In trying to close the technology gap, the Soviets have the advantage of following rather than leading. They can learn from U.S. successes and failures, saving billions of dollars by adopting existing technology and avoiding activities already demonstrated to be unpromising. Furthermore, their massive military production capacity can quickly turn new system designs into large numbers of fielded systems. The Soviets could never overcome our lead if they only played catch-up, but they can also draw on a large and improving technology base of their own.

There are troubling indications that the U.S. technological lead in fielded equipment, as well as in some underlying technologies, is eroding. The Defense Department's position is that "In recent years, the U.S.S.R. has significantly reduced the lead previously held by the United States and its Allies in technologies of military importance."[3] Both the time to produce the next generation of major items of equipment (tanks, airplanes, ships, missiles, etc.) and the time to translate new technological discoveries into fielded equipment are increasing. The latter is particularly ominous because once a technology is discovered, the United States is more or less in a race with the Soviets to get it into the field. If, for example, the United States develops a particular technology 3 years before the Soviets learn about it, but takes 4 years longer than the Soviets do to turn it into fielded equipment, the U.S. lead will have been negated. Furthermore, if each year the Soviets produce three times as many pieces of equipment using that new technology as the United States does, the United States will find itself behind in fielded capability.

U.S. equipment tends to be complex and costly, and therefore tends to get built slowly

[1] Quality of equipment is not the only factor that matters. Numbers, particularly numbers of the most advanced equipment actually in the field, are important. So are factors such as training, leadership, geography, and logistics.

[2] The difficulty of maintaining a meaningful technological lead may itself call into question the validity of relying on a strategy that requires such a lead. That, however, is a separate topic. This report begins with the premise that the United States seeks to maintain its technological lead.

[3] U.S. Department of Defense, *Soviet Military Power*, 1986, p. 103.

once production starts. Much time is taken getting the "bugs" out of new systems and training crews to be proficient in their use. This reflects a technological emphasis on higher military performance at the expense of factors such as cost and maintainability, and an emphasis on the technology of design over the technology of production. Cost reductions on the subsystem and component levels generally fail to translate into less costly systems. On the bright side, once the bugs are out, many recent U.S. systems have proven more reliable, available, maintainable, and operable than their predecessors. And as Soviet equipment becomes more complex it also tends to be plagued with the problems attributed to U.S. systems.

Congress is concerned over the health of the defense technology base. Particular concerns include the apparently lengthening time to translate laboratory advances into effective and dependable fielded systems; declining U.S. leadership in vital high-technology industries; and a downward trend in the proportion of the defense budget devoted to the technology base. The Senate Committee on Armed Services has asked the Office of Technology Assessment (OTA) to examine the health of the U.S. defense technology base and suggest options for exploiting its strengths and remedying its weaknesses. This special report is the first product of that project. It describes the defense technology base, presents significant technology base problems now facing the Nation, and discusses the issues Congress will confront in dealing with those problems. It also describes how the Department of Defense is organized to manage its technology base programs and discusses the roles of the major government research organizations that contribute to the defense technology base. In the course of the discussion it mentions, but does not analyze, solutions that have been proposed to some of the problems. These suggested solutions, and others, will be explored in later OTA work.[4]

The remainder of this chapter presents the principal findings of this special report. Because this is an interim product, these are largely observations of the staff and outside experts. Chapter 2 is a summary of the report, which elaborates on the principal findings and provides background material. Chapters 3 through 5 present the data and analyses on which these findings are based.

[4]Solutions have been suggested and analyzed in the 1987 *Defense Science Board Study on Technology Base Management*. Office of the Under Secretary of Defense for Acquisition, March 1988.

PRINCIPAL FINDINGS

The health of the defense technology base depends on many complex factors and is affected by policy in diverse areas. It responds to actions Congress takes regarding the Defense Department technology base programs; overall government science and technology policy; and industrial, trade and fiscal strategies that are relevant to vital high-technology industries. In deciding what to do about the defense technology base, Congress faces two broad issues:

1. Are the government programs that affect the health of the defense technology base appropriately organized, staffed, managed, and funded; and what can be done to ensure that they are?
2. Do government policies toward industry support the existence and maintenance of a healthy industrial technology base, both defense-oriented and commercial, from which defense developments can be drawn; and what can be done to ensure that they do?

Resolving these broad issues will entail addressing a number of component issues.

- The defense technology base resides in a broad range of institutions that includes

DoD laboratories, other government laboratories, universities, private research facilities, defense industries, and "dual-use" civilian industries. As the civilian industries move increasingly to the cutting edge of technology, the defense technology base becomes embedded in—and largely inseparable from—the national technology base. The Defense Department technology base programs are major contributors to the defense technology base, but they are far from all of it.

- The Defense Department's system for managing its technology base programs has recently been overhauled as part of the general reorganization of the acquisition system. But it remains to be seen whether this will lead to fundamental improvements in the way technology base programs are planned and managed. One basic question is whether the system works as well as can be expected, or whether major improvements can be brought about.
- Observers in government and industry believe that DoD is finding it increasingly difficult to attract and keep the skilled management personnel necessary to the functioning of its technology base programs. This appears to be, at least in part, a result of Civil Service salary structures and Congress' efforts to limit the movement of personnel between industry and the Defense Department.
- Funding for technology base programs is particularly vulnerable during times of tight budgets. The rapid spend-out rates of technology base programs mean that cuts in R&D go farther toward reducing deficits than similar size cuts in procurement programs. And the lack of obvious, tangible outputs from R&D projects makes the value of individual programs difficult to define. Technology base programs are particularly vulnerable to "raiding" to support programs in procurement or the later stages of development. Congress will have to determine what it thinks are proper levels of funding, which may entail acting as an advocate for technology base funding when DoD seeks to reduce it. The optimal level of funding is difficult, if not impossible, to gauge accurately. However, funding that fluctuates widely from year to year is inefficient and can be very disruptive. Congress faces the very difficult decision of whether it should be actively involved in the selection of technology base programs and the determination of specific funding levels, or whether instead it should give DoD managers wide latitude to construct programs within agreed overall funding levels.
- The government laboratories that together perform about one-third of the technology base program work have been the subject of a vast amount of study and discussion. There has been significant concern over the quality and value of their work, and the ability of the laboratories to attract and keep top-quality personnel. Many experts perceive them as uneven in quality and utility. Suggestions have been made regarding changing the relationships of some laboratories to their parent organizations, altering laboratory management structures (i.e., removing them from Civil Service), and improving their ability to compete for and compensate researchers.
- The United States is becoming increasingly dependent on foreign sources for defense technology. Some of this—like increasing involvement in NATO cooperative programs—is intentional. But much of it is a consequence of the movement abroad of high-technology industries, particularly those that deal primarily in the commercial marketplace. Reliance on foreign sources makes more technology available, distributes the costs of technical advances, and ties the Nation closer to its allies. But dependence on others risks losing access to technology, if political or economic conditions change. The United States faces basic policy issues of how much dependence on others for defense technology is advisable, and how much the Nation should spend to retain domestic sources of technology.

- The foreign dependence issue is most pronounced in the "dual-use" sector: those high-technology industries that sell primarily in the international commercial marketplace, but provide important technology and products as components of defense systems. High-technology products are increasingly manufactured outside the United States, raising concern that the ability to design at the leading edge will follow manufacturing, reducing DoD's access to the technology it needs. Other nations have national policies to attract, nurture, and protect high-technology industries. These tax, trade, and other policies contribute to the continuing deterioration of U.S.-based industries. Failure to counter conditions which cause U.S.-based companies to move offshore will allow the deterioration to continue, affecting national defense. If Congress chooses to address these issues, it is important that national security be part of that consideration.
- The defense industry is highly regulated. Government controls and regulations tend to discourage innovative small- and medium-sized companies from entering the business and create competitive advantages for those companies with experience in the specifics of selling to the government. Detailed specifications for military hardware tend to limit the availability of commercial products for defense needs. Moreover, many in industry believe that the government maintains an adversarial relationship with industry, to the detriment of the defense effort.
- There is concern that, in the defense sector, government regulations inhibit both product innovation and the application of advanced manufacturing technology to plant modernization. Companies can recover part of the cost of innovation from the government through the Independent Research and Development (IR&D) reimbursements. But this program has been controversial, in part because it has become complex and difficult to understand.
- Despite the United States' superior graduate education programs, there is concern—particularly within DoD and the defense industries—that U.S. citizens are not becoming scientists and engineers at a sufficiently high rate.
- Many experts believe that the long delays in getting new technology into the field arise not in the technology base, but in the subsequent programs that translate the products of the technology base into new systems. Full-scale development and production times are increasing, and the longer it takes to develop and build a system, the older its technology will be when it finally reaches the field. Unfortunately, adding new technology to a system already under development is likely to delay it still further. Inserting new technology through retrofitting fielded systems or block upgrades of systems in production might get new technology into the field faster than waiting for an entirely new system to be developed. Changes in the organizational links among developers, planners, operators, and technologists also have the potential for speeding the progress of technology into the field.

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